FITTING LOSS COEFFICIENTS

This material provides coefficients for various fittings and loss-inducing components of a duct system. Covering both rectangular and circular ducting, this material references many sources and provides the most commonly used items in each category. The categories of fittings in this material are linked here for ease of navigation:

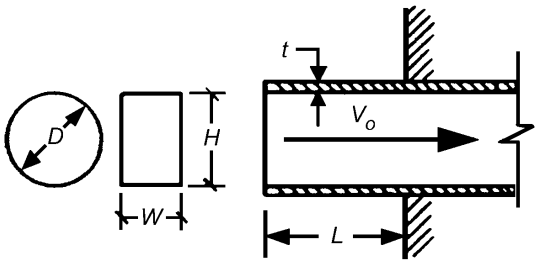
- **Entries**
- **Exits**
- **Elbows**
- **Transitions**
- **Junctions (Tees, Wyes, Crosses)**
- **Obstructions**
- **Fan-System Connections**

Note that for actual projects, use of the *ASHRAE Duct Fitting Database* (DFDB) is recommended. The DFDB includes more than 220 round, rectangular, and flat oval fittings. It is available in electronic form and has the capability to be linked to duct design programs.

1 ENTRIES

1-1 Duct Mounted in Wall (Hood, Nonenclosing, Flanged, and Unflanged)
(Idelchik et al. 1986, Diagram 3-1)

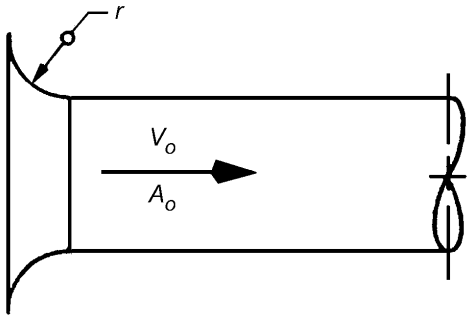
General. If entry has a screen, use Fitting 6-7 to calculate screen resistance.



Rectangular: $D = 2HW/(H + W)$

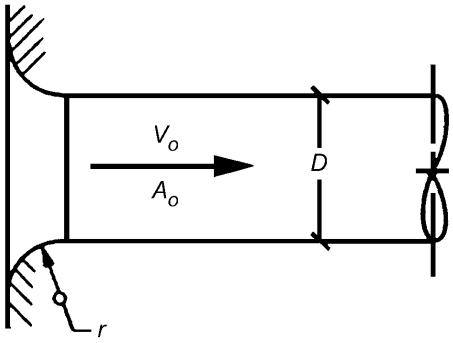
	C_o						
	L/*D*						
t*/*D	**0**	**0.002**	**0.01**	**0.05**	**0.2**	**0.5**	**≥1.0**
≈0	0.50	0.57	0.68	0.80	0.92	1.0	1.0
0.02	0.50	0.51	0.52	0.55	0.66	0.72	0.72
≥0.05	0.50	0.50	0.50	0.50	0.50	0.50	0.50

1-2 Smooth Converging Bellmouth Without End Wall (Idelchik et al. 1986, Diagram 34)



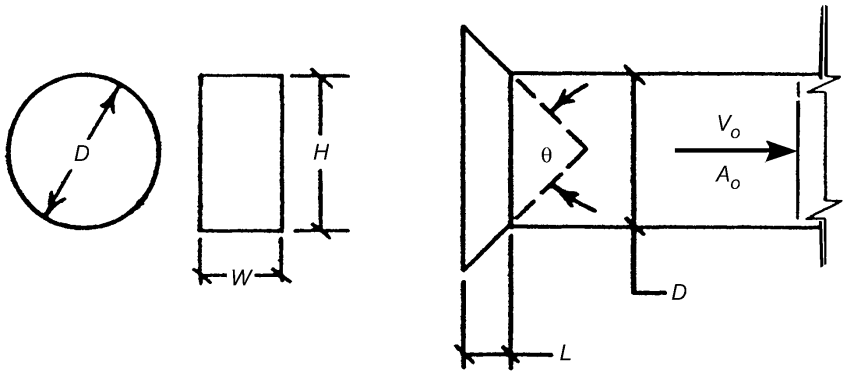
r/*D*	0	0.01	0.02	0.03	0.04	0.05
C_o	1.0	0.87	0.74	0.61	0.51	0.40
r/*D*	0.06	0.08	0.10	0.12	0.16	≥0.20
C_o	0.32	0.20	0.15	0.10	0.06	0.03

1-3 Smooth Converging Bellmouth with End Wall (Idelchik et al. 1986, Diagram 3-4)



r/D	0	0.01	0.02	0.03	0.04	0.05
C_o	0.50	0.44	0.37	0.31	0.26	0.22
r/D	0.06	0.08	0.10	0.12	0.16	≥0.20
C_o	0.20	0.15	0.12	0.09	0.06	0.03

1-4 Conical Converging Bellmouth Without End Wall, Round and Rectangular

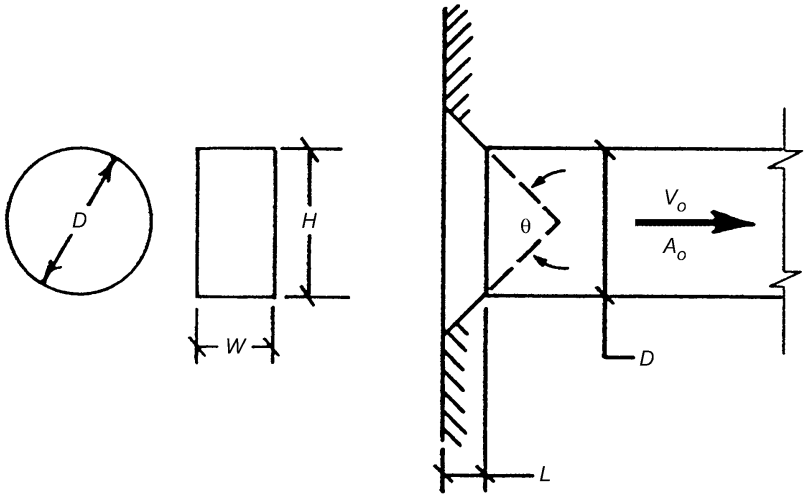


Rectangular: $D = 2HW/(H + W)$

	C_o									
	θ, degrees									
L/D	**0**	**10**	**20**	**30**	**45**	**60**	**90**	**120**	**150**	**180**
0.025	1.0	0.96	0.93	0.90	0.85	0.80	0.72	0.64	0.57	0.50
0.05	1.0	0.93	0.86	0.80	0.73	0.67	0.60	0.56	0.52	0.50
0.10	1.0	0.80	0.67	0.55	0.46	0.41	0.41	0.43	0.46	0.50
0.25	1.0	0.68	0.45	0.30	0.21	0.17	0.21	0.28	0.38	0.50
0.60	1.0	0.46	0.27	0.18	0.14	0.13	0.19	0.27	0.37	0.50
1.0	1.0	0.32	0.20	0.14	0.11	0.10	0.16	0.24	0.35	0.50

1-5 Conical Converging Bellmouth with End Wall, Round and Rectangular

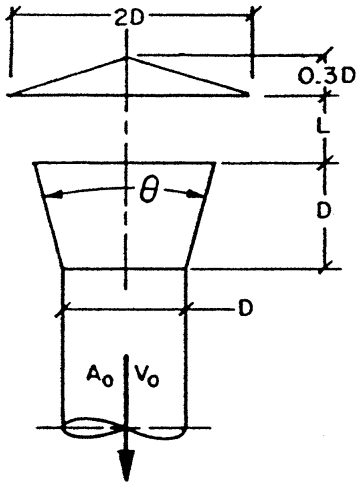
(Idelchik et al. 1986, Diagram 3-7)



Rectangular: $D = 2HW/(H + W)$

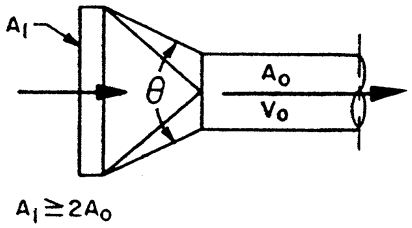
	C_o									
	θ, degrees									
L/D	**0**	**10**	**20**	**30**	**45**	**60**	**90**	**120**	**150**	**180**
0.025	0.50	0.47	0.45	0.43	0.41	0.40	0.42	0.44	0.46	0.50
0.05	0.50	0.45	0.41	0.36	0.32	0.30	0.34	0.39	0.44	0.50
0.075	0.50	0.42	0.35	0.30	0.25	0.23	0.28	0.35	0.43	0.50
0.10	0.50	0.39	0.32	0.25	0.21	0.18	0.25	0.33	0.41	0.50
0.15	0.50	0.37	0.27	0.20	0.16	0.15	0.23	0.31	0.40	0.50
0.60	0.50	0.27	0.18	0.13	0.11	0.12	0.20	0.30	0.40	0.50

1-6 Intake Hood (Idelchik et al. 1986, Diagram 3-18)



	C_o								
	L/D								
θ, degrees	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.8**	**1.0**	**4.0**
0	2.63	1.83	1.53	1.39	1.31	1.19	1.08	1.06	1.0
15	1.32	0.77	0.60	0.48	0.41	0.30	0.28	0.25	0.25

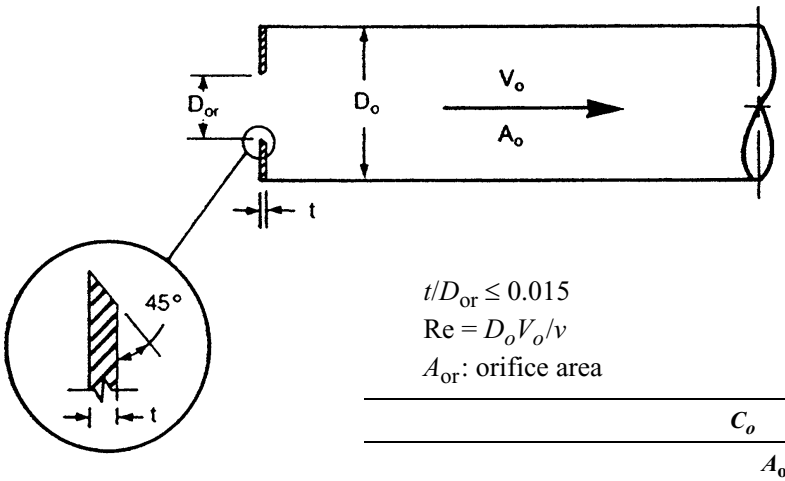
1-7 Hood, Tapered, Flanged or Unflanged (Brandt and Steffy 1946)



θ is major angle for rectangular hoods

Hood Shape: Round										
θ, degrees	0	20	40	60	80	100	120	140	160	180
C_o	1.0	0.11	0.06	0.09	0.14	0.18	0.27	0.32	0.43	0.50
Hood Shape: Square or Rectangular										
θ, degrees	0	20	40	60	80	100	120	140	160	180
C_o	1.0	0.19	0.13	0.16	0.21	0.27	0.33	0.43	0.53	0.62

1-8 Orifice, Sharp-Edged, Inlet Duct (Idelchik et al. 1986; Diagrams 3-12, 3-14, and 4-19)



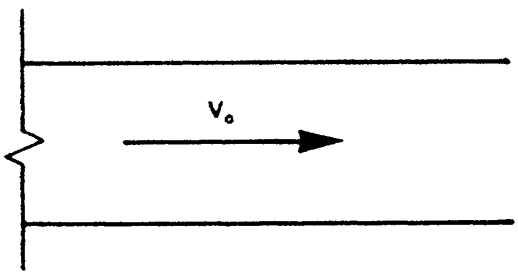
$t/D_{or} \le 0.015$
$Re = D_o V_o / v$
A_{or}: orifice area

C_o								
	A_{or}/A_o							
Re × 10^{-3}	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
4	45	18	7.9	3.9	2.3	1.3	0.83	0.51
10	49	20	9.2	4.4	2.7	1.5	0.96	0.59
20	50	21	9.3	4.9	2.9	1.6	1.1	0.65
100	55	23	11.0	5.6	3.3	1.9	1.2	0.75

2 EXITS

General. If exit has a screen, use Fitting 6-7 to calculate screen resistance.

2-1 Exit, Abrupt, Round and Rectangular (Idelchik et al. 1986, Diagram 11-1)



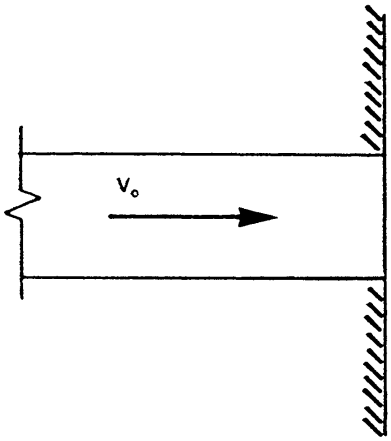
Uniform Velocity Distribution

$C_o = 1.0$

Exponential, Sinusoidal, Asymmetrical, and Parabolic Velocity Distribution

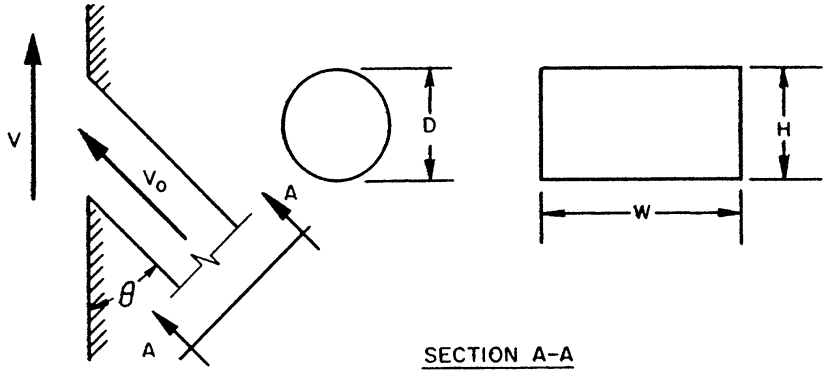
C_o varies from 1.0 to 3.67. For details, consult Idelchik et al. (1986), Diagram 11-1.

2-2 Exit, Abrupt, Round and Rectangular, with End (Idelchik et al. 1986, Diagrams 5-2 and 5-4)



$C_o = 0.88$

2-3 Exit, Duct Flush with Wall, Flow along Wall (Idelchik et al. 1986, Diagram 11-2)



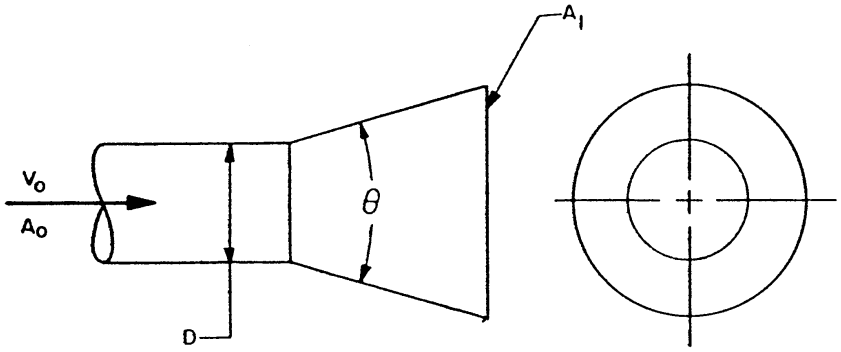
Round

	C_o				
	V/V_o				
θ, degrees	**0**	**0.5**	**1.0**	**1.5**	**2.0**
≤45	1.0	1.0	1.1	1.3	1.6
60	1.0	0.90	1.1	1.4	1.6
90	1.0	0.80	0.95	1.4	1.7
120	1.0	0.80	0.95	1.3	1.7
150	1.0	0.82	0.83	1.0	1.3

Rectangular

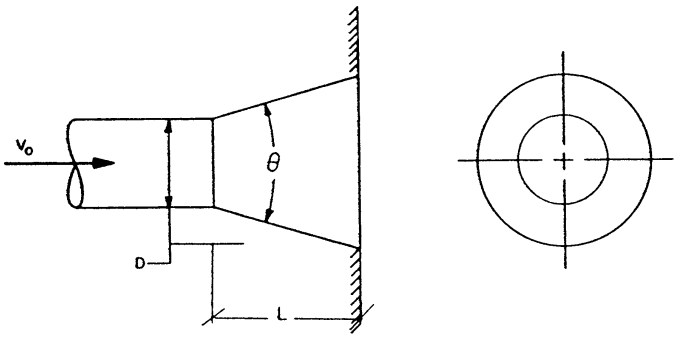
		C_o				
		V/V_o				
Aspect Ratio (*H*/*W*)	**θ, degrees**	**0**	**0.5**	**1.0**	**1.5**	**2.0**
≤0.2	≤90	1.0	0.95	1.2	1.5	1.8
	120	1.0	1.1	1.1	1.4	1.9
	150	1.0	0.95	0.95	1.4	1.8
0.5–2.0	≤45	1.0	1.0	1.1	1.3	1.6
	60	1.0	0.90	1.1	1.4	1.6
	90	1.0	0.80	0.95	1.4	1.7
	120	1.0	0.80	0.95	1.3	1.7
	150	1.0	0.82	0.83	1.0	1.3
≥5	45	1.0	0.92	0.93	1.1	1.3
	60	1.0	0.87	0.87	1.0	1.3
	90	1.0	0.82	0.80	0.97	1.2
	120	1.0	0.80	0.76	0.90	0.98

2-4 Exit, Round, Diverging (Idelchik et al. 1986, Diagram 11-3)



	C_o						
	θ, degrees						
A_1/A_o	**8**	**10**	**14**	**20**	**30**	**45**	**≥60**
2	0.36	0.33	0.37	0.51	0.90	1.0	1.0
4	0.24	0.21	0.28	0.40	0.70	0.99	1.0
6	0.20	0.19	0.26	0.37	0.67	0.99	1.0
10	0.18	0.16	0.24	0.36	0.68	0.99	1.0
16	0.16	0.16	0.20	0.36	0.66	0.99	1.0

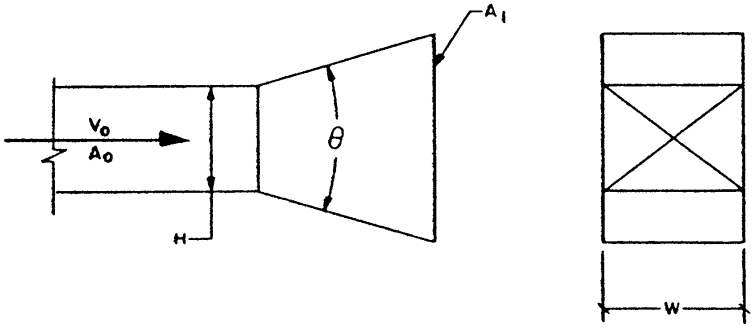
2-5 Exit, Round, with End Wall Transition (Idelchik et al. 1986, Diagram 5-8)



θ = optimum angle

L/D	**0.5**	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**8.0**	**10**	**12**	**14**
θ, degrees	34	24	16	13	11	10	9	8	7	6	6
C_o	0.41	0.32	0.24	0.20	0.17	0.15	0.14	0.12	0.11	0.11	0.10

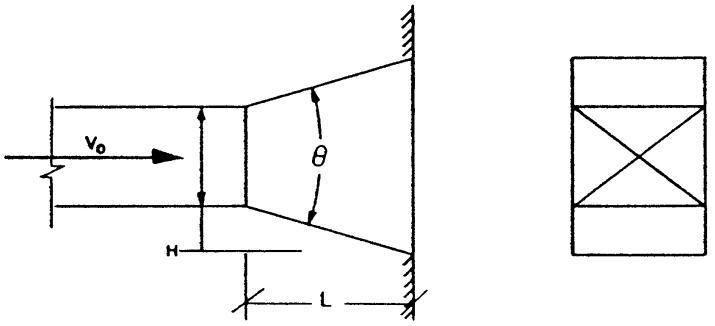
2-6 Exit, Rectangular, Two Sides Parallel, Diverging, Symmetrical (Idelchik et al. 1986, Diagram 11-6)



$0.5 \le H/W \le 2.0$

	C_o						
	θ, degrees						
A_1/A_o	**8**	**10**	**14**	**20**	**30**	**45**	**≥60**
2	0.50	0.51	0.56	0.63	0.80	0.96	1.0
4	0.34	0.38	0.48	0.63	0.76	0.91	1.0
6	0.32	0.34	0.41	0.56	0.70	0.84	0.96

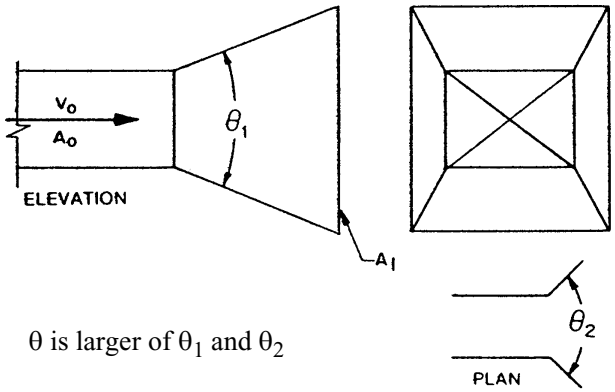
2-7 Exit, Rectangular, with Wall, Two Sides Parallel, Symmetrical, Diverging (Idelchik et al. 1986, Diagram 5-10)



θ = optimum angle

L/H	**0.5**	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**8.0**	**10**	**12**	**14**
θ, degrees	50	35	25	21	18	16	15	13	12	11	10
C_o	0.53	0.44	0.35	0.31	0.28	0.25	0.24	0.22	0.20	0.19	0.19

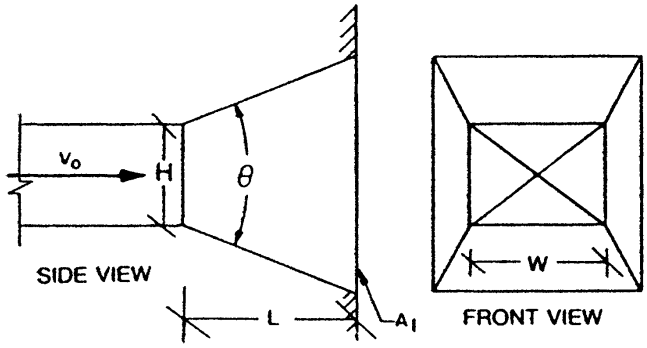
2-8 Exit, Rectangular, Pyramidal, Diverging (Idelchik et al. 1986, Diagram 11-5)



θ is larger of θ_1 and θ_2

	C_o						
	θ, degrees						
A_1/A_o	8	10	14	20	30	45	≥60
2	0.65	0.68	0.74	0.82	0.92	1.1	1.1
4	0.53	0.60	0.69	0.78	0.90	1.0	1.1
6	0.50	0.57	0.66	0.77	0.91	1.0	1.1
10	0 45	0.53	0.64	0.74	0.85	0.97	1.1

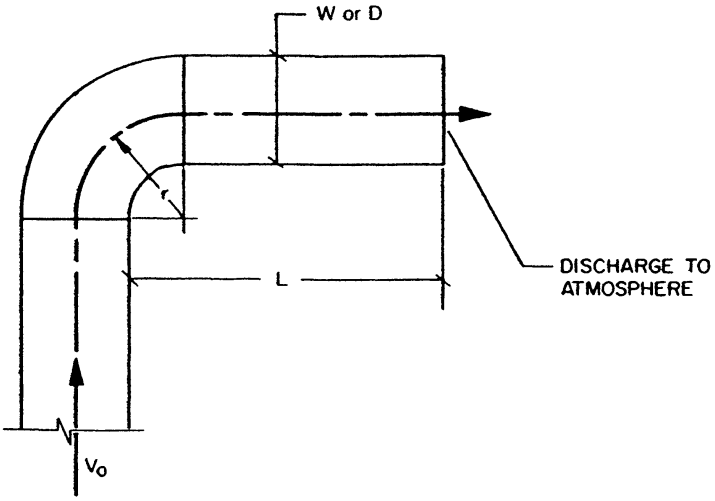
2-9 Exit, Rectangular, with Wall, Pyramidal, Diverging (Idelchik et al. 1986, Diagram 5-9)



$D = 2HW/(H + W)$
θ = optimum angle

L/D	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10	12	14
θ, degrees	26	19	13	11	9	8	7	6	6	5	5
C_o	0.49	0.40	0.30	0.26	0.23	0.21	0.19	0.17	0.16	0.15	0.14

2-10 Exit, Discharge to Atmosphere from a 90° Elbow, Rectangular and Round (Note: Elbow Loss Included) (Idelchik et al. 1986, Diagram 11-14)



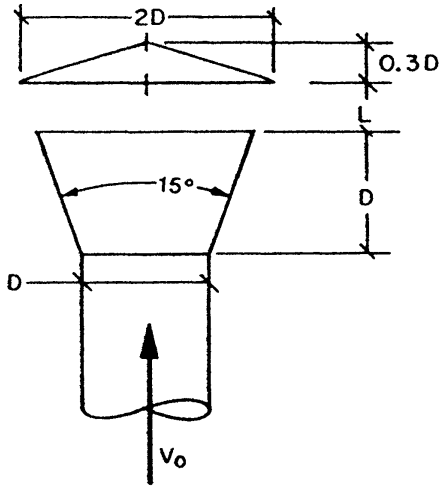
Rectangular

	C_o									
	L/W									
r/W	**0**	**0.5**	**1.0**	**1.5**	**2.0**	**3.0**	**4.0**	**6.0**	**8.0**	**12.0**
0	3.0	3.1	3.2	3.0	2.7	2.4	2.2	2.1	2.1	2.0
0.75	2.2	2.2	2.1	1.8	1.7	1.6	1.6	1.5	1.5	1.5
1.0	1.8	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.2
1.5	1.5	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
2.5	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Round (r/D = 1.0)

L/D	0.9	1.3
C_o	1.5	1.4

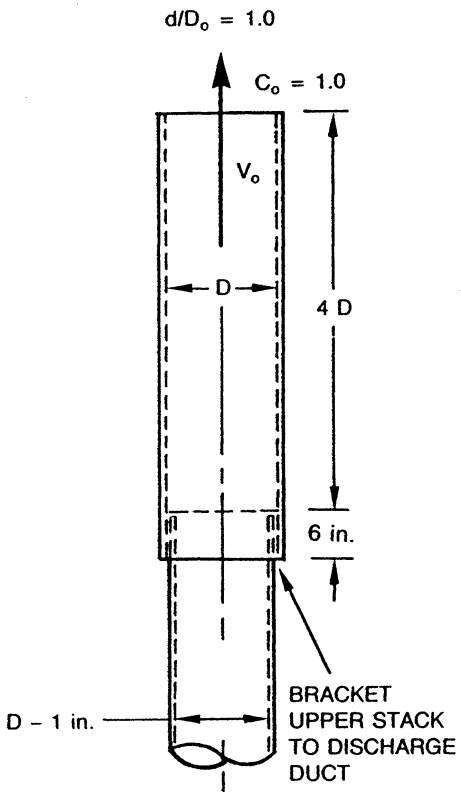
2-11 Exhaust Hood (Idelchik et al. 1986, Diagram 11-16)



L/D	**0.1**	**0.2**	**0.25**	**0.3**	**0.35**	**0.4**	**0.5**
C_o	2.6	1.2	1.0	0.80	0.70	0.65	0.60

Poor Design—Should Not Be Used

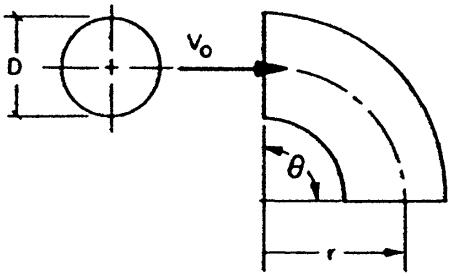
2-12 Stackhead (Idelchik et al. 1986, Diagram 11-23)



d/*D*	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
C_o	130	41	17	8.1	4.4	2.6	1.6	1.0

3 ELBOWS

3-1 Elbow, Smooth Radius (Die Stamped), Round (Locklin 1950, Equation A-10)

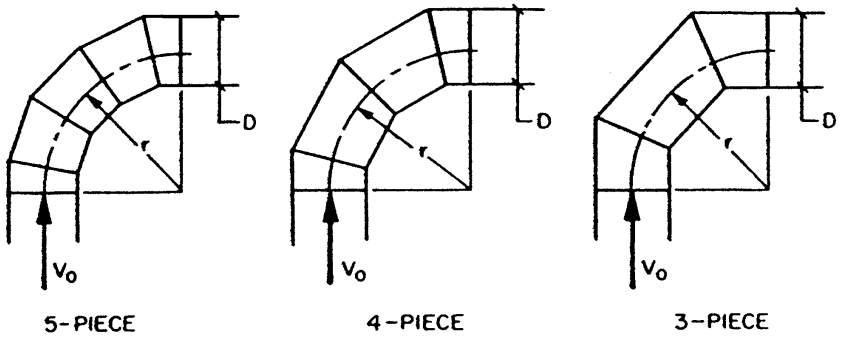


$$C_o = K_q C'_o$$

Coefficients for 90° Elbows						
r/*D*	0.5	0.75	1.0	1.5	2.0	2.5
C'_o	0.71	0.33	0.22	0.15	0.13	0.12

Angle Correction Factors K_q (Idelchik et al. 1986, Diagram 6-1):											
θ, degrees	0	20	30	45	60	75	90	110	130	150	180
K_θ	0	0.31	0.45	0.60	0.78	0.90	1.00	1.13	1.20	1.28	1.40

3-2 Elbows; 5-, 4-, and 3-Pieces, Round (Locklin 1950, Figure 10)



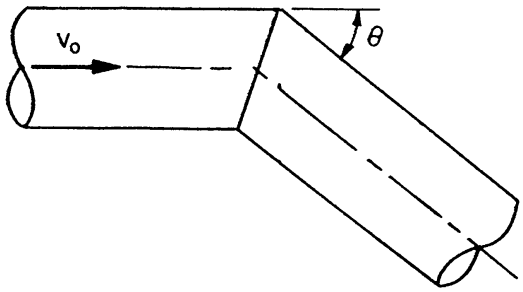
Coefficients for 90° Elbows (C'_o)

No. of Pieces	r/D 0.75	1.0	1.5	2.0
5	0.46	0.33	0.24	0.19
4	0.50	0.37	0.27	0.24
3	0.54	0.42	0.34	0.33

Angle Correction Factors K_q (Idelchik et al. 1986, Diagram 6-1)

θ, degrees	0	20	30	45	60	75	90	110	130	150	180
K_θ	0	0.31	0.45	0.60	0.78	0.90	1.00	1.13	1.20	1.28	1.40

3-3 Elbow, Mitered, Round (Idelchik et al. 1986, Diagram 6-5)



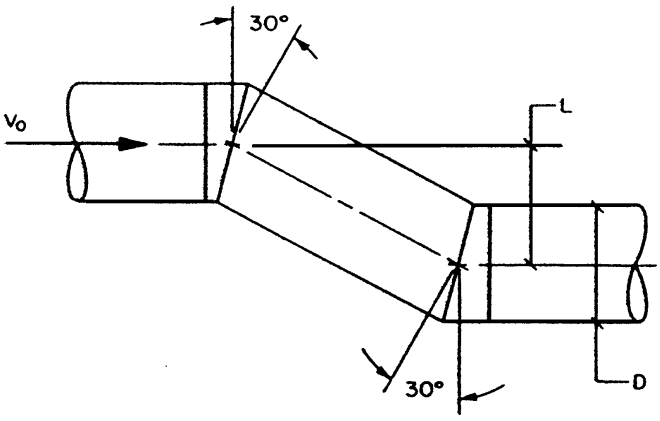
$$C_o = K_{Re} C'_o$$

θ, degrees	20	30	45	60	75	90
C'_o	0.08	0.16	0.34	0.55	0.81	1.2

Reynolds Number Correction Factors: *M/hc*

Re × 10^{-4}	1	2	3	4	6	8	10	≥14
K_{Re}	1.40	1.26	1.19	1.14	1.09	1.06	1.04	1.0

3-4 Elbows, 30,° Z-Shaped, Round



$$C_o = K_{Re} C'_o$$

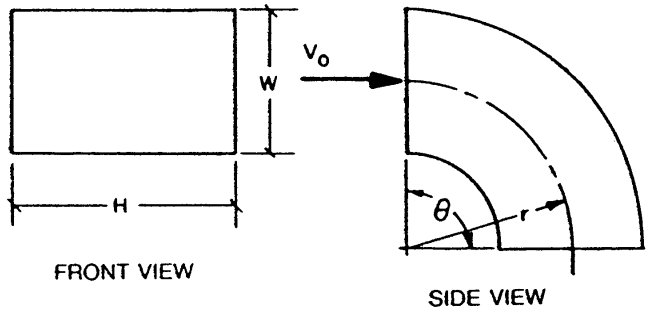
L/D	0	0.5	1.0	1.5	2.0	2.5	3.0
C'_o	0	0.15	0.15	0.16	0.16	0.16	0.16

Reynolds Number Correction Factors

Re × 10^{-4}	1	2	3	4	6	8	10	≥14
K_{Re}	1.40	1.26	1.19	1.14	1.09	1.06	1.04	1.0

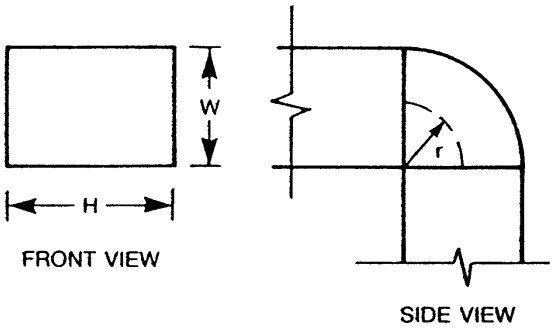
3-5 Elbow, Without Vanes, Rectangular (Idelchik et al. 1986, Diagram 6-1)

Smooth Radius



$$C_o = K_\theta K_{Re} C'_o$$

90°, Sharp Throat Radius Heel ($r/W = 0.5$)



$$C_o = K_{Re} C'_o$$

Coefficients for 90° Elbows (C'_o)

	H/W										
r/W	**0.25**	**0.5**	**0.75**	**1.0**	**1.5**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**8.0**
0.5	1.3	1.3	1.2	1.2	1.1	1.0	1.0	1.1	1.1	1.2	1.2
0.75	0.57	0.52	0.48	0.44	0.40	0.39	0.39	0.40	0.42	0.43	0.44
1.0	0.27	0.25	0.23	0.21	0.19	0.18	0.18	0.19	0.20	0.21	0.21
1.5	0.22	0.20	0.19	0.17	0.15	0.14	0.14	0.15	0.16	0.17	0.17
2.0	0.20	0.18	0.16	0.15	0.14	0.13	0.13	0.14	0.14	0.15	0.15

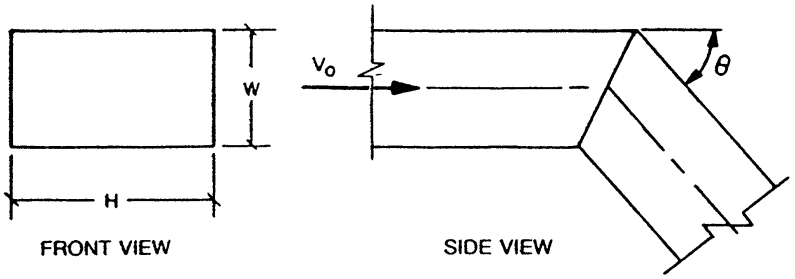
Angle Correction Factor

θ, degrees	0	20	30	45	60	75	90	110	130	150	180
K_θ	0	0.31	0.45	0.60	0.78	0.90	1.00	1.13	1.20	1.28	1.40

Reynolds Number Correction Factor (K_{Re})

	$Re \times 10^{-4}$								
r/W	**1**	**2**	**3**	**4**	**6**	**8**	**10**	**14**	**≥20**
0.5	1.40	1.26	1.19	1.14	1.09	1.06	1.04	1.0	1.0
≥0.75	2.0	1.77	1.64	1.56	1.46	1.38	1.30	1.15	1.0

3-6 Elbow, Mitered, Rectangular (Idelchik et al. 1986, Diagram 6-5)



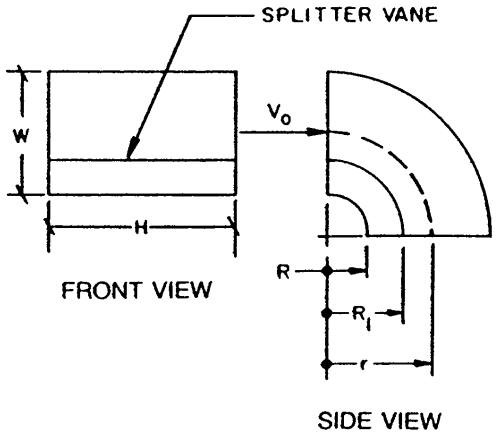
$$C_o = K_{Re} C'_o$$

	C'_o										
θ, degrees	*H/W*										
	0.25	**0.5**	**0.75**	**1.0**	**1.5**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**8.0**
20	0.08	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.05	0.05	0.05
30	0.18	0.17	0.17	0.16	0.15	0.15	0.13	0.13	0.12	0.12	0.11
45	0.38	0.37	0.36	0.34	0.33	0.31	0.28	0.27	0.26	0.25	0.24
60	0.60	0.59	0.57	0.55	0.52	0.49	0.46	0.43	0.41	0.39	0.38
75	0.89	0.87	0.84	0.81	0.77	0.73	0.67	0.63	0.61	0.58	0.57
90	1.3	1.3	1.2	1.2	1.1	1.1	0.98	0.92	0.89	0.85	0.83

Reynolds Number Corrections Factors								
Re × 10^{-4}	**1**	**2**	**3**	**4**	**6**	**8**	**10**	**≥14**
K_{Re}	1.40	1.26	1.19	1.14	1.09	1.06	1.04	1.0

3-7 Elbow, Smooth Radius with Splitter Vanes, Rectangular
(Locklin 1950, Equation 10; Madison and Parker 1936)

a. One Splitter Vane



$C_o = K_\theta C'_o$

$R_1 = R/CR$

where

R = throat radius

R_1 = splitter vane radius

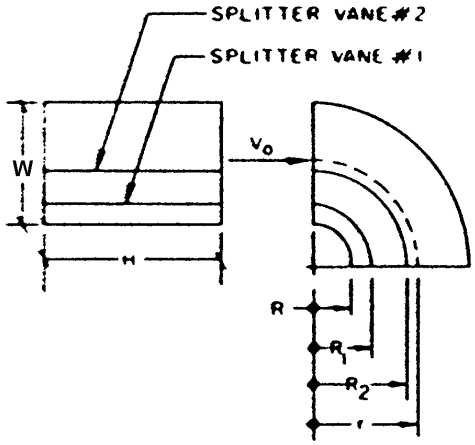
CR = curve ratio (values from Table 3-7.a)

K_θ = angle factor (see Fitting 3-1 for values)

Table 3-7.a Coefficients for Elbows with One Splitter Vane

			C'_o										
			H/W										
R/W	r/W	CR	0.25	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0
0.05	0.55	0.218	0.52	0.40	0.43	0.49	0.55	0.66	0.75	0.84	0.93	1.0	1.1
0.10	0.60	0.302	0.36	0.27	0.25	0.24	0.30	0.35	0.39	0.42	0.46	0.49	0.52
0.15	0.65	0.361	0.28	0.21	0.18	0.19	0.20	0.22	0.25	0.26	028	0.30	0.32
0.20	0.70	0.408	0.22	0.16	0.14	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21
0.25	0.75	0.447	0.18	013	0.11	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.15
0.30	0.80	0.480	0.15	0.11	0.09	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12
0.35	0.85	0.509	0.13	0.09	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09
0.40	0.90	0.535	0.11	0.08	0.07	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07
0.45	0.95	0.557	0.10	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
0.50	1.00	0.577	0.09	0.06	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05

b. Two Splitter Vanes



$C_o = K_\theta C'_o$

$R_1 = R/CR$

$R_2 = R_1/CR = R/CR^2$

where

R = throat radius

R_1 = splitter vane # 1 radius

R_2 = splitter vane # 2 radius

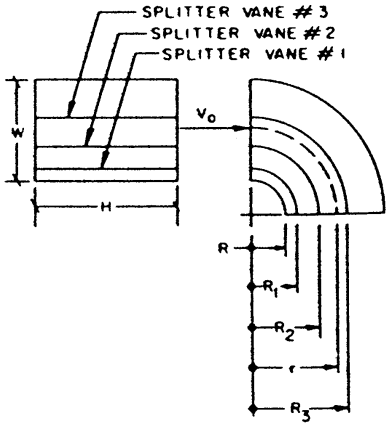
CR = curve ratio (value from Table 3-7.b)

K_θ = angle factor (see Note 3 for values)

Table 3-7.b Coefficients for Elbow with Two Splitter Vanes

			C'_o										
			H/W										
R/W	r/W	CR	0.25	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0
0.05	0.55	0.362	0.26	0.20	0.22	0.25	0.28	0.33	0.37	0.41	0.45	0.48	0.51
0.10	0.60	0.450	0.17	0.13	0.11	0.12	0.13	0.15	0.16	0.17	0.19	0.20	0.21
0.15	0.65	0.507	0.12	0.09	0.08	0.08	0.08	0.09	0.10	0.10	0.11	0.11	0.11
0.20	0.70	0.550	0.09	0.07	0.06	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07
0.25	0.75	0.585	0.08	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05
0.30	0.80	0.613	0.06	004	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04

c. Three Splitter Vanes



$C_o = K_\theta C'_o$

$R_1 = R/CR$

$R_2 = R_1/\mathrm{CR} = R/\mathrm{CR}^2$

$R_3 = R_2/\mathrm{CR} = R/\mathrm{CR}^3$

where

R = throat radius

R_1 = splitter vane # l radius

R_2 = splitter vane # 2 radius

R_3 = splitter vane # 3 radius

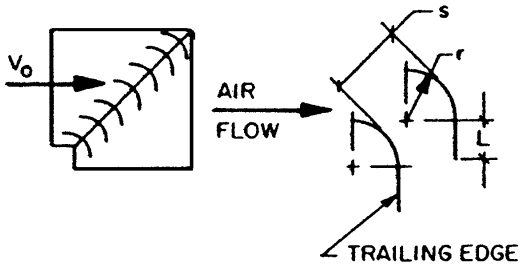
CR = curve ratio (value from Table 3-7.c)

K_θ = angle factor (see Note 3 for values)

Table 3-7.c Coefficients for Elbow with Three Splitter Vanes (C'_o)

			H/W										
R/W	***r/W***	***CR***	**0.25**	**0.5**	**1.0**	**1.5**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**
0.05	0.55	0.467	0.11	0.10	0.12	0.13	0.14	0.16	0.18	0.19	0.21	0.22	0.23
0.10	0.60	0.549	0.07	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.09

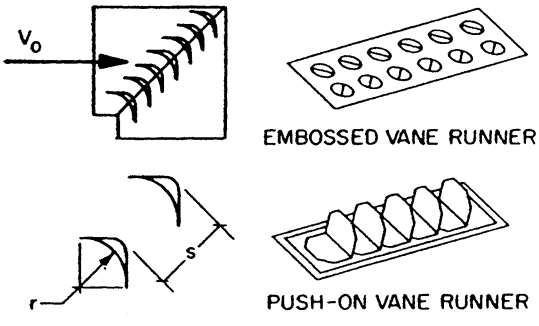
3-8 Elbow, Mitered, with Single-Thickness Vanes, Rectangular (Rozell 1974)



Design No.	Dimensions, in.			C_o
	r	*s*	*L*	
1[a]	2.0	1.5	0.75	0.12
2	4.5	2.25	0	0.15
3	4.5	3.25	1.60	0.18

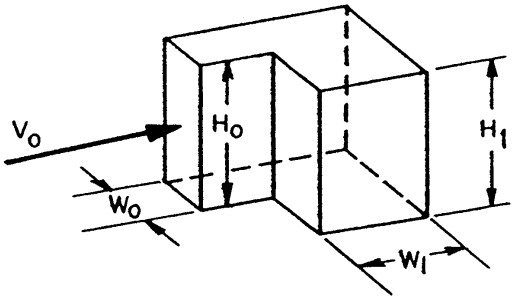
[a] When extension of trailing edge is not provided for this vane, losses are approximately unchanged for single elbows, but increase considerably for elbows in series.

3-9 Elbow, Mitered, with Double-Thickness Vanes, Rectangular (Rozell 1974)



Design No.	Dimensions, in.		C_o Velocity V_o, fpm				Vane Runner
	r	s	1000	2000	3000	4000	
1	2.0	1.5	0.27	0.22	0.19	0.17	Embossed
2	2.0	1.5	0.33	0.29	0.26	0.23	Push-On
3	2.0	2.13	0.38	0.31	0.27	0.24	Embossed
4	4.5	3.25	0.26	0.21	0.18	0.16	Embossed

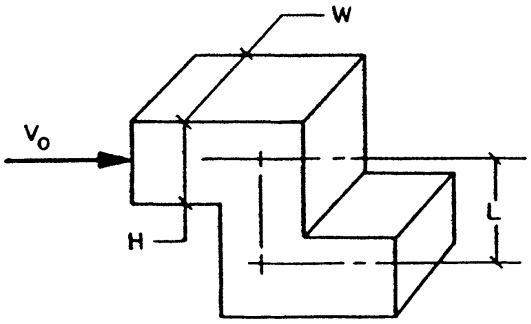
3-10 Elbow, Variable Inlet/Outlet Areas, Rectangular (Idelchik et al. 1986, Diagram 6-4)



	C'_o					
	W_1/W_o					
H_o/W_o	**0.6**	**0.8**	**1.2**	**1.4**	**1.6**	**2.0**
0.25	1.8	1.4	1.1	1.1	1.1	1.1
1.0	1.7	1.4	1.0	095	0.90	0.84
4.0	1.5	1.4	0.81	0.76	0.72	0.66
∞	1.5	1.0	0.69	0.63	0.60	0.55

Reynolds Number Correction Factor								
$Re \times 10^{-4}$	1	2	3	4	6	8	10	≥14
K_{Re}	1.40	1.26	1.19	1.14	1.09	1.06	1.04	1.0

3-11 Elbows, 90°, Z-Shaped, Rectangular (Idelchik et al. 1986, Diagram 6-11)



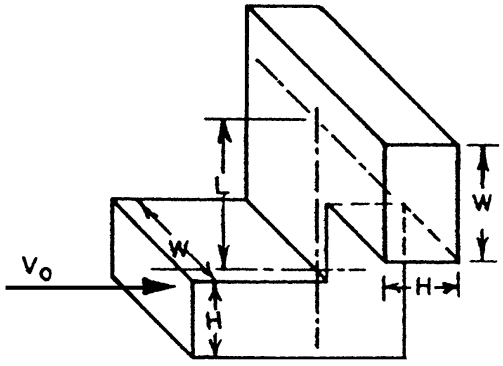
$$C = K\,K_{Re}C'_o$$

Coefficients for W/H = 1.0										
L/H	0	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
C'_o	0	0.62	0.90	1.6	2.6	3.6	4.0	4.2	4.2	4.2
L/H	2.4	2.8	3.2	4.0	5.0	6.0	7.0	9.0	10.0	¥
C'_o	3.7	3.3	3.2	3.1	2.9	2.9	2.8	2.7	2.5	2.3

Reynolds Number Correction Factor								
$Re \times 10^{-4}$	1	2	3	4	6	8	10	≥14
K_{Re}	1.40	1.26	1.19	1.14	1.09	1.06	1.04	1.0

Apply the Following Factor for Other Than H/W = 1.0										
W/H	0.25	0.50	0.75	1.0	1.5	2.0	3.0	4.0	6.0	8.0
K	1.10	1.07	1.04	1.0	0.95	0.90	9.83	0.78	0.72	0.70

3-12 Combined 90° Elbows Lying in Different Planes, Rectangular (Idelchik et al. 1986, Diagram 6-11)



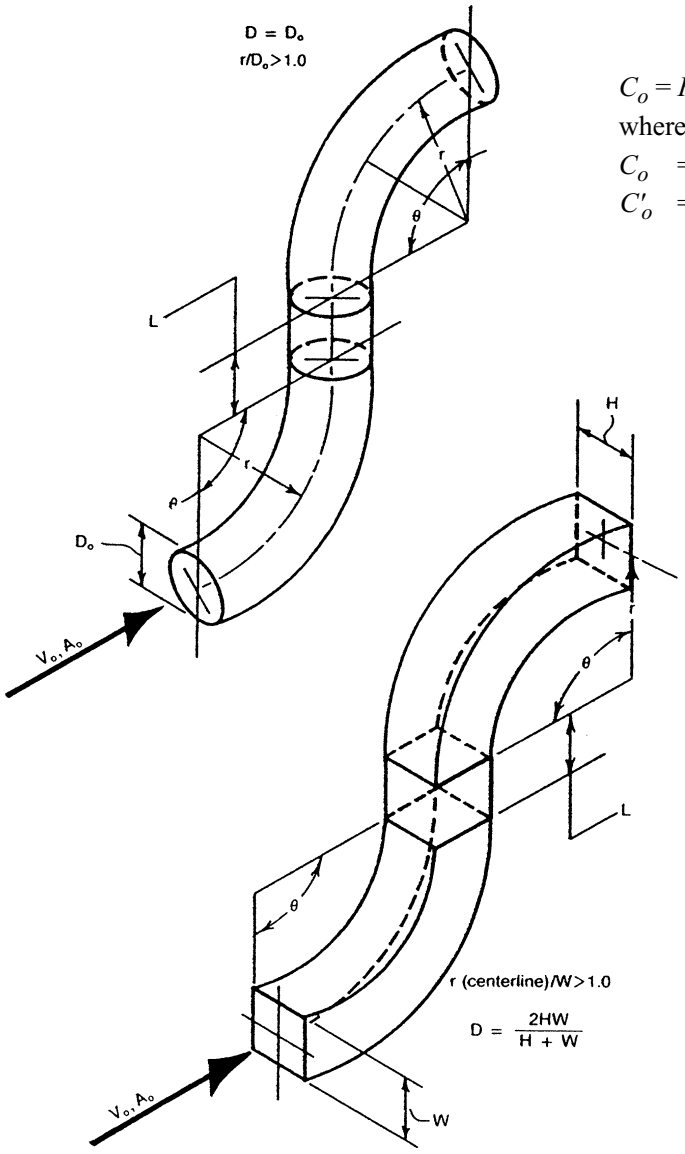
$$C_o = K\,K_{Re}C'_o$$

Coefficients for Square Ducts										
L/W	0	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
C'_o	1.2	2.4	2.9	3.3	3.4	3.4	3.4	3.3	3.2	3.1
L/W	2.4	2.8	3.2	4.0	5.0	6.0	7.0	9.0	10.0	¥
C'_o	3.2	3.2	3.2	3.0	2.9	2.8	2.7	2.5	2.4	2.3

Reynolds Number Correction Factor								
$Re \times 10^{-4}$	1	2	3	4	6	8	10	≥14
K_{Re}	1.40	1.26	1.19	1.14	1.09	1.06	1.04	1.0

Apply the Following Factor for Other Than H/W = 1.0										
H/W	0.25	0.50	0.75	1.0	1.5	2.0	3.0	4.0	6.0	8.0
K	1.10	1.07	1.04	1.0	0.95	0.90	0.83	0.78	0.72	0.70

3-13 Offset, S-Shaped (Gooseneck), Rectangular and Round (Idelchik et al. 1986, Diagram 6-16)



$C_o = KC'_o$

where

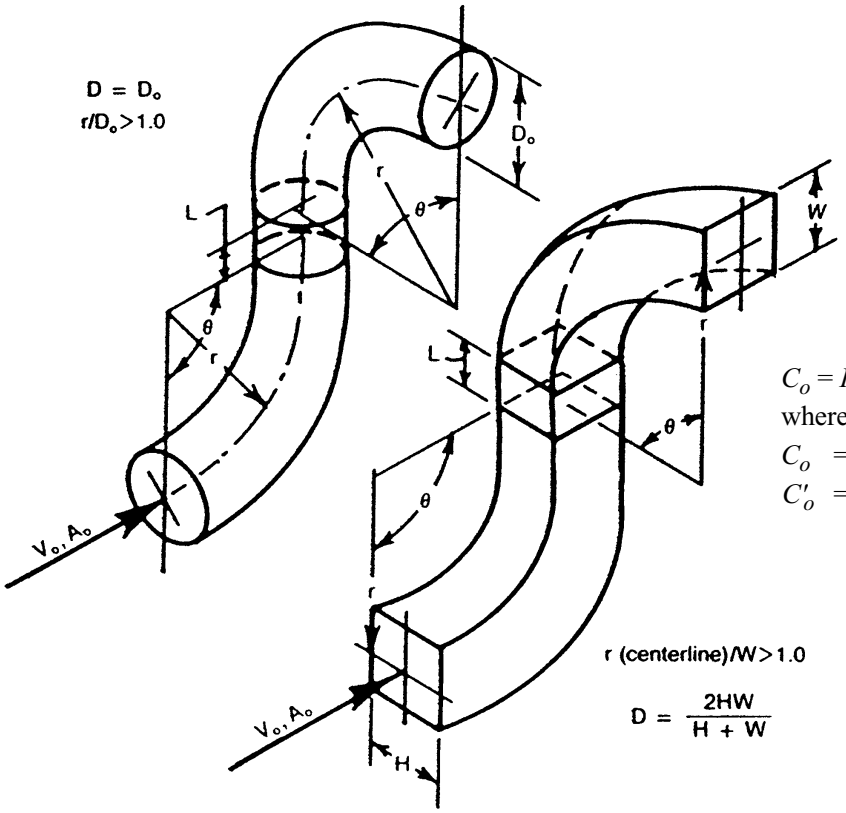
C_o = offset loss coefficient

C'_o = single elbow loss coefficient (see Fittings 3-1, 3-2, and 3-5)

	K														
θ,	***L/D***														
degrees	**0**	**1**	**2**	**3**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**25**	**≥40**
15	0.20	0.42	0.60	0.78	0.94	1.16	1.20	1.15	1.08	1.05	1.02	1.00	1.10	1.25	2.0
30	0.40	0.65	0.88	1.16	1.20	1.18	1.12	1.06	1.06	1.15	1.28	1.40	1.50	1.70	2.0
45	0.60	1.06	1.20	1.23	1.20	1.08	1.03	1.08	1.17	1.30	1.42	1.55	1.65	1.80	2.0
60	1.05	1.38	1.37	1.28	1.15	1.06	1.16	1.30	1.42	1.54	1.66	1.76	1.85	1.95	2.0
75	1.50	1.58	1.46	1.30	1.27	1.30	1.37	1.47	1.57	1.68	1.75	1.80	1.88	1.97	2.0
90	1.70	1.67	1.40	1.37	1.38	1.47	1.55	1.63	1.70	1.76	1.82	1.88	1.92	1.98	2.0

3-14 Offset, S-Shaped in Two Planes 90° Apart, Rectangular and Round

(Idelchik et al. 1986, Diagram 6-16)



$C_o = KC'_o$

where

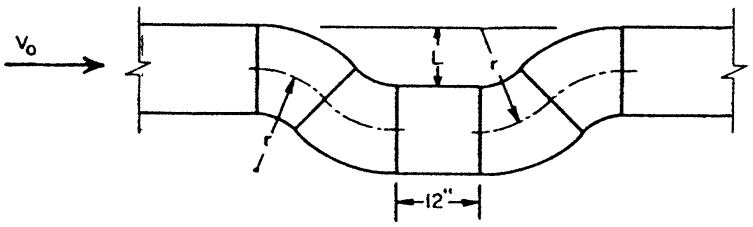
C_o = offset loss coefficient

C'_o = single elbow loss coefficient (see Fittings 3-1, 3-2, and 3-5)

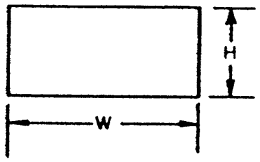
	K												
θ, degrees	***L/D***												
	0	**1**	**2**	**3**	**4**	**6**	**8**	**10**	**12**	**14**	**20**	**25**	**40**
60	2.0	1.90	1.50	1.35	1.30	1.20	1.25	1.50	1.63	1.73	1.85	1.95	2.0
90	2.0	1.80	1.60	1.55	1.55	1.65	1.80	1.90	1.93	1.98	2.0	2.0	2.0

3-15 Elbows (4), 45°, Smooth Radius, Rectangular, Arranged to Go Around an Obstruction

(SMACNA 1981, Table 6-14K)



SIDE VIEW



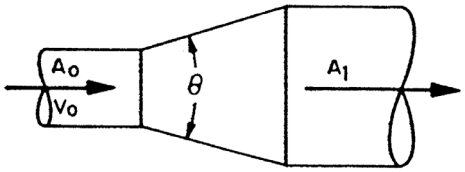
FRONT VIEW

$W/H = 4$, $r/H = 1.5$, $L = 1.5H$

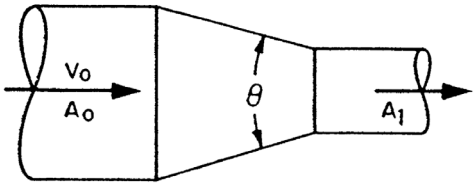
V_o, fpm	800	1200	1600	2000	2400
C_o	0.18	0.22	0.24	0.25	0.26

4 TRANSITIONS

4-1 Transition, Round (Idelchik et al. 1986, Diagrams 5-2 and 5-22)



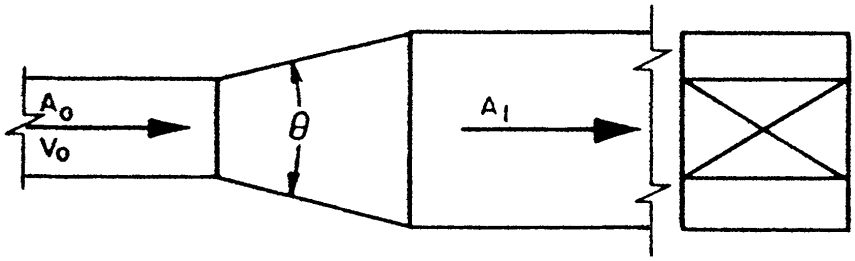
$A_o/A_1 < 1$



$A_o/A_1 > 1$

	C_o									
	θ, degrees									
A_o/A_1	10	15	20	30	45	60	90	120	150	180
0.06	0.21	0.29	0.38	0.60	0.84	0.88	0.88	0.88	0.88	0.88
0.1	0.21	0.28	0.38	0.59	0.76	0.80	0.83	0.84	0.83	0.83
0.25	0.16	0.22	0.30	0.46	0.61	0.68	0.64	0.63	0.62	0.62
0.5	0.11	0.13	0.19	0.32	0.33	0.33	0.32	0.31	0.30	0.30
1	0	0	0	0	0	0	0	0	0	0
2	0.20	0.20	0.20	0.20	0.22	0.24	0.48	0.72	0.96	1.0
4	0.80	0.64	0.64	0.64	0.88	1.1	2.7	4.3	5.6	6.6
6	1.8	1.4	1.4	1.4	2.0	2.5	6.5	10	13	15
10	5.0	5.0	5.0	5.0	6.5	8.0	19	29	37	43

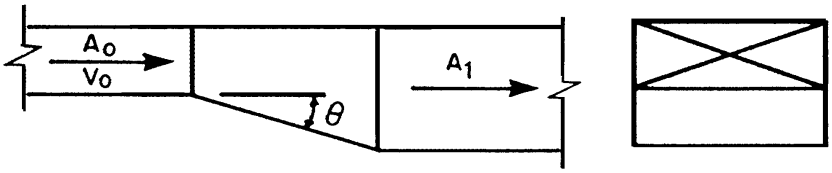
4-2 Transition, Rectangular, Two Sides Parallel, Symmetrical (Idelchik et al. 1986, Diagram 5-5)[a]



	C_o									
	θ, degrees									
A_o/A_1	10	15	30	30	45	60	90	120	150	180
0.06	0.26	0.27	0.40	0.56	0.71	0.86	1.00	0.99	0.98	0.98
0.1	0.24	0.26	0.36	0.53	0.69	0.82	0.93	0.93	0.92	0.91
0.25	0.17	0.19	0.22	0.42	0.60	0.68	0.70	0.69	0.67	0.66
0.5	0.14	0.13	0.15	0.24	0.35	0.37	0.38	0.37	0.36	0.35
1	0	0	0	0	0	0	0	0	0	0
2	0.23	0.20	0.20	0.20	0.24	0.28	0.54	0.78	1.0	1.1
4	0.81	0.64	0.64	0.64	0.88	1.1	2.8	4.4	5.7	6.6
6	1.8	1.4	1.4	1.4	2.0	2.5	6.6	10	13	15
10	5.0	5.0	5.0	5.0	6.5	8.0	19	29	37	43

[a] $A_o/A_1 > 1$ is tentative (adapted from Fitting 4-1 data).

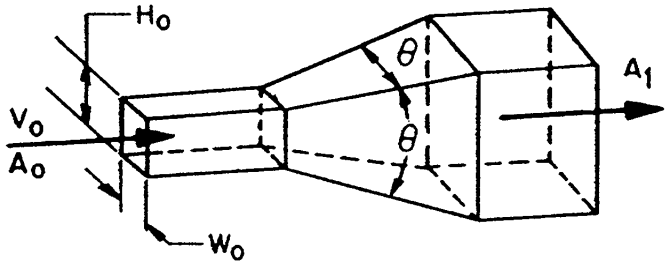
4-3 Transition, Rectangular, Three Sides Straight[a]



	C_o						
	θ, degrees						
A_o/A_1	10	15	20	30	45	60	90
0.06	0.26	0.27	0.40	0.56	0.71	0.86	1.00
0.1	0.24	0.26	0.36	0.53	0.69	0.82	0.93
0.25	0.17	0.19	0.22	0.42	0.60	0.68	0.70
0.5	0.14	0.13	0.15	0.24	0.35	0.37	0.38
1	0	0	0	0	0	0	0
2	0.23	0.20	0.20	0.20	0.24	0.28	0.54
4	0.81	0.64	0.64	0.64	0.88	1.1	2.8
6	1.8	1.4	1.4	1.4	2.0	2.5	6.6
10	5.0	5.0	5.0	5.0	6.5	8.0	19

[a]Tentative (assumed same as Fitting 4-2 data).

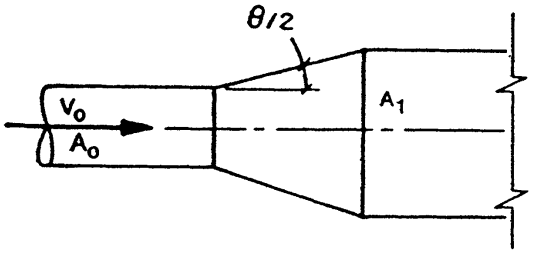
4-4 Transition, Rectangular, Pyramidal (Idelchik et al. 1986, Diagram 5-4)[a]

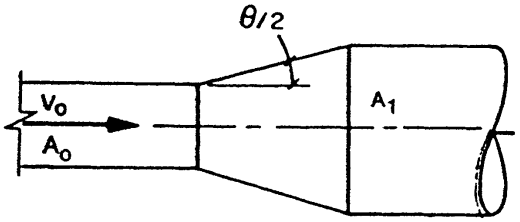


	C_o									
	θ, degrees									
A_o/A_1	10	15	20	30	45	60	90	120	150	180
0.06	0.26	0.30	0.44	0.54	0.53	0.65	0.77	0.88	0.95	0.98
0.1	0.24	0.30	0.43	0.50	0.53	0.64	0.75	0.84	0.89	0.91
0.25	0.20	0.25	0.34	0.36	0.45	0.52	0.58	0.62	0.64	0.64
0.5	0.14	0.15	0.20	0.21	0.25	0.30	0.33	0.33	0.33	0.32
1	0	0	0	0	0	0	0	0	0	0
2	0.23	0.22	0.21	0.20	0.22	0.2	0.49	0.74	0.99	1.1
4	0.84	0.68	0.68	0.64	0.88	1.1	2.7	4.3	5.6	6.6
6	1.8	1.5	1.5	1.4	2.0	2.5	6.5	10	13	15
10	5.0	5.0	5.1	5.0	6.5	8.0	19	29	37	43

[a]A_o/A_1 >1 is tentative (adapted from Fitting 4-1 data).

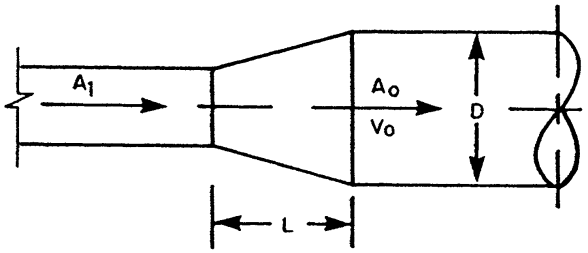
4-5 Transition, Round/Rectangular (Idelchik et al. 1986, Diagram 5-27)





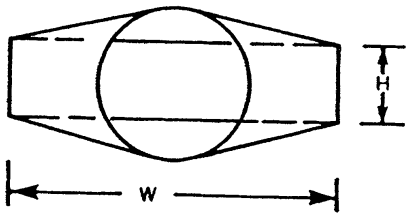
	C_o								
	θ, degrees								
A_1/A_o	8	10	14	20	30	45	60	90	180
2	0.14	0.15	0.20	0.25	0.30	0.33	0.33	0.33	0.30
4	0.20	0.25	0.34	0.45	0.52	0.58	0.62	0.64	0.64
6	0.21	0.30	0.42	0.53	0.63	0.72	0.78	0.79	0.79
≥10	0.24	0.30	0.43	0.53	0.64	0.75	0.84	0.89	0.88

4-6 Transition, Rectangular to Round (Idelchik et al. 1986, Diagram 5-26)



$\text{Re} = DV_o/v$

$B = W/H(A_o/A_1)^2$



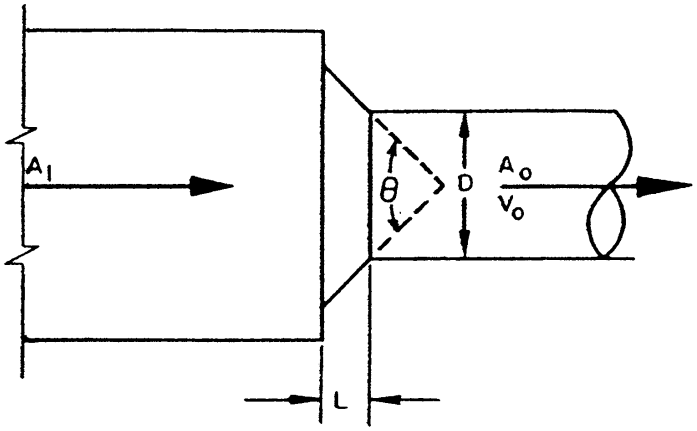
C_o for $A_o > A_1$ and $H < D$

Re × 10^{-4}	L/D	B 0.1	0.5	1	2	5	10	20	50
1	1	0.46	0.48	0.50	0.55	0.70	0.94	1.4	2.9
	1.5	0.46	0.47	0.49	0.53	0.64	0.82	1.2	2.3
	2	0.46	0.47	0.48	0.50	0.58	0.71	0.98	1.8
	3	0.45	0.46	0.46	0.48	0.51	0.57	0.69	1.0
	4	0.45	0.46	0.46	0.46	0.48	0.51	0.56	0.73
	5	0.45	0.46	0.46	0.47	0.49	0.53	0.61	0.84
2	1	0.41	0.43	0.46	0.51	0.66	0.90	1.4	2.9
	1.5	0.41	0.43	0.45	0.48	0.59	0.78	1.1	2.2
	2	0.41	0.42	0.44	0.46	0.54	0.67	0.93	1.7
	3	0.41	0.42	0.42	0.43	0.47	0.53	0.64	0.99
	4	0.41	0.41	0.41	0.42	0.44	0.46	0.52	0.69
	5	0.41	0.41	0.42	0.43	0.45	0.49	0.57	0.80
5	1	0.31	0.33	0.35	0.40	0.55	0.79	1.3	2.8
	1.5	0.31	0.32	0.34	0.38	0.49	0.67	1.0	2.1
	2	0.31	0.32	0.33	0.36	0.43	0.57	0.83	1.6
	3	0.30	0.31	0.31	0.33	0.36	0.42	0.54	0.88
	4	0.30	0.31	0.31	0.31	0.33	0.36	0.41	0.58
	5	0.30	0.31	0.31	0.32	0.34	0.38	0.46	0.70
10	1	0.19	0.21	0.23	0.28	0.43	0.68	1.2	2.6
	1.5	0.19	0.20	0.22	0.26	0.37	0.55	0.92	2.0
	2	0.19	0.20	0.21	0.24	0.31	0.45	0.71	1.5
	3	0.19	0.19	0.20	0.21	0.24	0.30	0.42	0.77
	4	0.18	0.19	0.19	0.19	0.21	0.24	0.29	0.46
	5	0.18	0.19	0.19	0.20	0.22	0.26	0.34	0.58
20	1	0.07	0.09	0.12	0.17	0.31	0.56	1.1	2.5
	1.5	0.07	0.09	0.10	0.14	0.25	0.43	0.80	0.9
	2	0.07	0.08	0.09	0.12	0.20	0.33	0.59	1.4
	3	0.07	0.07	0.08	0.09	0.13	0.18	0.30	0.65
	4	0.07	0.07	0.07	0.08	0.10	0.12	0.18	0.34
	5	0.07	0.07	0.08	0.08	0.11	0.15	0.22	0.46
50	1	0.01	0.03	0.05	0.10	0.25	0.30	0.99	2.5
	1.5	0.01	0.02	0.04	0.08	0.19	0.37	0.74	1.8
	2	0.01	0.02	0.03	0.06	0.13	0.27	0.53	1.3
	3	0	0.01	0.02	0.03	0.06	0.12	0.24	0.58
	4	0	0.01	0.01	0.01	0.03	0.06	0.11	0.28
	5	0	0.01	0.01	0.02	0.04	0.08	0.16	0.40

C_o for $A_o < A_1$ and $H < D$

Re × 10^{-4}	L/D	B 0.1	1	5	10	20	50
1	1	0.27	0.27	0.28	0.29	0.31	0.37
	3	0.27	0.27	0.28	0.29	0.30	0.33
	4	0.27	0.27	0.28	0.28	0.29	0.32
	5	0.27	0.27	0.27	0.27	0.27	0.27
2	1	0.25	0.25	0.26	0.27	0.29	0.35
	3	0.25	0.25	0.25	0.26	0.28	0.33
	4	0.25	0.25	0.25	0.26	0.27	0.30
	5	0.25	0.25	0.25	0.25	0.25	0.25
5	1	0.18	0.18	0.19	0.20	0.22	0.28
	3	0.18	0.18	0.19	0.20	0.22	0.27
	4	0.18	0.18	0.19	0.19	0.20	0.23
	5	0.18	0.18	0.18	0.18	0.18	0.18
10	1	0.11	0.11	0.12	0.13	0.15	0.21
	3	0.11	0.11	0.12	0.13	0.14	0.19
	4	0.11	0.11	0.12	0.12	0.13	0.16
	5	0.11	0.11	0.11	0.11	0.11	0.11
20	1	0.04	0.04	0.05	0.06	0.08	0.14
	3	0.04	0.04	0.05	0.06	0.07	0.12
	4	0.04	0.04	0.05	0.05	0.06	0.09
	5	0.04	0.04	0.04	0.04	0.04	0.04
50	1	0	0	0.01	0.02	0.04	0.10
	3	0	0	0.01	0.02	0.04	0.09
	4	0	0	0.01	0.01	0.02	0.05
	5	0	0	0	0	0	0

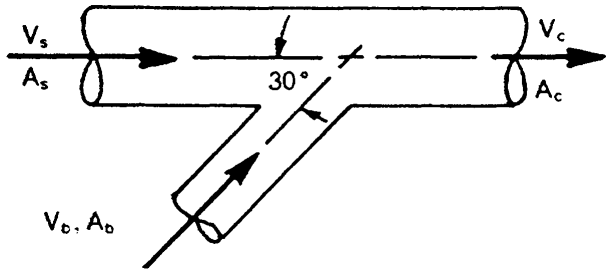
4-7 Transition, Rectangular to Round, Stepped, Conical (Idelchik et al. 1986, Diagram 4-9)



		C_o									
		θ, degrees									
A_o/A_1	L/H	0	10	20	30	45	60	90	120	150	180
0.1	0.025	0.46	0.43	0.42	0.40	0.38	0.37	0.38	0.40	0.43	0.46
	0.05	0.46	0.42	0.38	0.33	0.30	0.28	0.31	0.36	0.41	0.46
	0.075	0.46	0.39	0.32	0.28	0.23	0.21	0.26	0.32	0.39	0.46
	0.1	0.46	0.36	0.30	0.23	0.19	0.17	0.23	0.30	0.38	0.46
	0.15	0.46	0.34	0.25	0.18	0.15	0.14	0.21	0.29	0.37	0.46
	0.3	0.46	0.31	0.22	0.16	0.13	0.13	0.20	0.28	0.37	0.46
	0.6	0.46	0.25	0.17	0.12	0.10	0.11	0.19	0.27	0.36	0.46
0.25	0.025	0.40	0.38	0.36	0.35	0.33	0.32	0.33	0.35	0.37	0.40
	0.05	0.40	0.36	0.33	0.29	0.26	0.24	0.27	0.31	0.35	0.40
	0.075	0.40	0.34	0.28	0.24	0.20	0.19	0.23	0.28	0.34	0.40
	0.1	0.40	0.31	0.26	0.20	0.17	0.14	0.20	0.26	0.33	0.40
	0.15	0.40	0.30	0.22	0.16	0.13	0.12	0.18	0.25	0.32	0.40
	0.3	0.40	0.27	0.19	0.14	0.11	0.11	0.18	0.25	0.32	0.40
	0.6	0.40	0.22	0.14	0.10	0.09	0.10	0.16	0.24	0.32	0.40
0.5	0.025	0.30	0.28	0.27	0.25	0.24	0.24	0.25	0.26	0.27	0.30
	0.05	0.30	0.27	0.24	0.21	0.19	0.18	0.20	0.23	0.26	0.30
	0.075	0.30	0.25	0.21	0.18	0.15	0.14	0.17	0.21	0.25	0.30
	0.1	0.30	0.23	0.19	0.15	0.12	0.11	0.15	0.19	0.24	0.30
	0.15	0.30	0.22	0.16	0.12	0.09	0.09	0.13	0.18	0.24	0.30
	0.3	0.30	0.20	0.14	0.10	0.08	0.08	0.13	0.18	0.24	0.30
	0.6	0.30	0.16	0.11	0.08	0.07	0.07	0.12	0.17	0.23	0.30
0.8	0.025	0.15	0.14	0.13	0.13	0.12	0.12	0.12	0.13	0.14	0.15
	0.05	0.15	0.13	0.12	0.11	0.10	0.09	0.10	0.12	0.13	0.15
	0.075	0.15	0.13	0.10	0.09	0.08	0.07	0.08	0.10	0.13	0.15
	0.1	0.15	0.12	0.10	0.07	0.06	0.05	0.07	0.10	0.12	0.15
	0.15	0.15	0.11	0.08	0.06	0.05	0.04	0.07	0.09	0.12	0.15
	0.3	0.15	0.10	0.07	0.05	0.04	0.04	0.07	0.09	0.12	0.15
	0.6	0.15	0.08	0.05	0.04	0.03	0.04	0.06	0.09	0.12	0.15

5 JUNCTIONS (Tees, Wyes, Crosses)

5-1 Wye, 30°, Converging (Idelchik et al. 1986, Diagram 7-1)



$A_S = A_C$

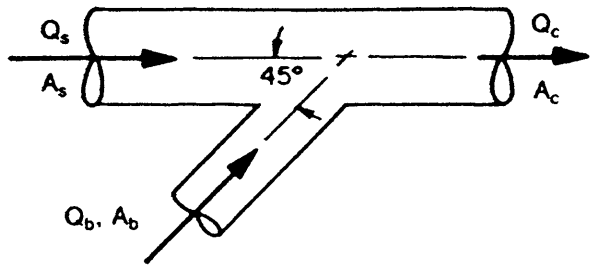
Branch, $C_{c,b}$

	A_b/A_c						
Q_b/Q_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.6**	**0.8**	**1.0**
0	–1.0	–1.0	–1.0	–0.9	–0.9	–0.9	–0.9
0.1	0.21	–0.46	–0.57	–0.51	0.53	–0.54	–0.54
0.2	3.1	0.37	–0.06	–0.16	0.23	–0.24	–0.28
0.3	7.6	1.5	0.50	0.15	0.04	–0.06	–0.08
0.4	14	3.0	1.2	0.42	0.19	0.13	0.12
0.5	21	4.6	1.8	0.53	0.24	0.19	0.15
0.6	30	6.4	2.6	0.77	0.35	0.25	0.17
0.7	41	8.5	3.4	0.99	0.42	0.28	0.22
0.8	54	12	4.2	1.2	0.47	0.29	0.25
0.9	58	14	5.3	1.4	0.49	0.29	0.22
1.0	84	17	6.3	1.6	0.49	0.21	0.15

Main, $C_{c,s}$

	A_b/A_c						
Q_b/Q_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.6**	**0.8**	**1.0**
0	0	0	0	0	0	0	0
0.1	0.02	0.11	0.13	0.15	0.16	0.17	0.17
0.2	–0.33	0.01	0.13	0.19	0.24	0.27	0.29
0.3	–1.1	–0.25	–0.01	0.10	0.22	0.30	0.35
0.4	–2.2	–0.75	–0.30	–0.05	0.17	0.26	0.36
0.5	–3.6	–1.4	–0.70	–0.35	0	0.21	0.32
0.6	–5.4	–2.4	–1.3	–0.70	–0.20	0.06	0.25
0.7	–7.6	–3.4	–2.0	–1.2	–0.50	–0.15	0.10
0.8	–10	–4.6	–2.7	–1.8	–0.90	–0.43	–0.15
0.9	–13	–6.2	–3.7	–2.6	–1.4	–0.80	–0.45
1.0	–16	–7.7	–4.8	–3.4	–1.9	–1.2	–0.75

5-2 Wye, 45° Converging, Round (Idelchik et al. 1986, Diagram 7-2)

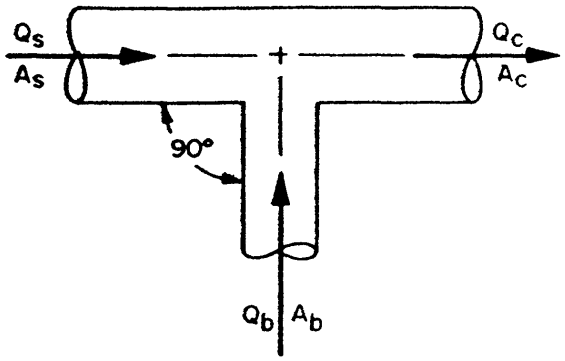


$A_S = A_C$

	$C_{c,b}$						
	A_b/A_c						
Q_b/Q_c	0.1	0.2	0 3	0.4	0.6	0.8	1.0
0	– 1.0	–1.0	–1.0	–0.90	–0.90	–0.80	–0.90
0.1	0.24	–0.45	–0.56	–0.50	–0.52	–0.53	–0.53
0.2	3.2	0.54	–0.02	–0.14	–0.21	–0.23	–0.23
0.3	8.0	1.6	0.60	0.23	0.06	0	–0.02
0.4	14	3.2	1.3	0.52	0.25	0.18	0.15
0.5	22	5.0	2.1	0.65	0.33	0.25	0.22
0.6	32	7.0	3.0	0.91	0.81	0.61	0.51
0.7	43	9.2	3.9	1.2	0.56	0.39	0.33
0.8	56	12	4.9	1.5	0.66	0.39	0.36
0.9	71	15	6.2	1.8	0.72	0.44	0.35
1.0	87	19	7.4	2.0	0.78	0.44	0.32

	$C_{c,s}$						
	A_b/A_c						
Q_b/Q_c	0.1	0.2	0.3	0.4	0.6	0.8	1.0
0	0	0	0	0	0	0	0
0.1	0.05	0.12	0.14	0.16	0.17	0.17	0.17
0.2	–0.20	0.17	0.22	0.27	0.27	0.29	0.31
0.3	–0.76	–0.13	0.08	0.20	0.28	0.32	0.40
0.4	–1.7	–0.50	–0.12	0.08	0.26	0.36	0.41
0.5	–2.8	–1.0	–0.49	–0.13	0.16	0.30	0.40
0.6	–4.3	–1.7	–0.87	–0.45	–0.04	0.20	0.33
0.7	–6.1	–2.6	–1.4	–0.85	–0.25	0.08	0.25
0.8	–8.1	3.6	–2.1	–1.3	–0.55	–0.17	0.06
0.9	–10	4.8	–2.8	–1.9	–0.88	–0.40	–0.18
1.0	–13	–6.1	–3.7	–2.6	–1.4	–0.77	–0.42

5-3 Tee, Converging, Round (Idelchik et al. 1986, Diagram 7-4)



$$A_s = A_c$$

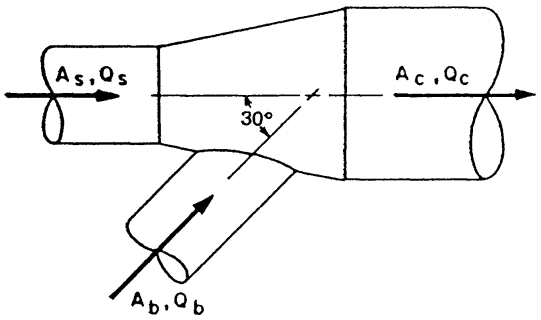
Branch, $C_{c,b}$

	A_b/A_c						
Q_s/Q_c	0.1	0.2	03	0.4	0.6	0.8	1.0
0	–1.0	–1.0	–1.0	–0.90	–0.90	–0.90	–0.90
0.1	0.40	–0.37	–0.51	–0.46	–0.50	–0.51	–0.52
0.2	3.8	0.72	0.17	–0.02	–0.14	–0.18	–0.24
0.3	9.2	2.3	1.0	0.44	0.21	0.11	–0.08
0.4	16	4.3	2.1	0.94	0.54	0.40	0.32
0.5	26	6.8	3.2	1.1	0.66	0.49	0.42
0.6	37	9.7	4.7	1.6	0.92	0.69	0.57
0.7	43	13	6.3	2.1	1.2	0.88	0.72
0.8	65	17	7.9	2.7	1.5	1.1	0.86
0.9	82	21	9.7	3.4	1.8	1.2	0.99
1.0	101	26	12	4.0	2.1	1.4	1.1

Main

Q_s/Q_c	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
$C_{c,s}$	0	0.16	0.27	0.38	0.46	0.53	0.57	0.59	0.60	0.59	0.55

5-4 Wye, 30° Converging, Round, Conical Main (Sepsy and Pies 1973)



Branch, $C_{c,b}$

		Q_b/Q_s									
A_s/A_c	A_b/A_c	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**
0.3	0.2	–2.4	–0.11	1.8	3.4	4.8	6.0	7.1	8.0	8.9	9.7
	0.3	–2.8	–1.3	0.14	0.72	1.4	2.0	2.4	2.8	3.2	3.5
0.4	0.2	–1.4	0.61	2.3	3.8	5.2	6.3	7.3	8.3	9.1	9.8
	0.3	–1.8	–0.54	0.42	1.2	1.8	2.3	2.7	3.1	3.4	3.7
	0.4	–1.9	–0.89	–0.17	0.36	0.76	1.1	1.3	1.5	1.7	1.9
0.5	0.2	–0.82	0.97	2.6	4.0	5.3	6.4	7.4	8.3	9.1	9.9
	0.3	–1.2	–0.15	0.71	1.4	2.0	2.5	2.9	3.3	3.6	3.9
	0.4	– 1.4	–0.54	0.06	0.50	0.85	1.1	1.3	1.5	1.7	1.8
	0.5	–1.4	–0.66	–0.15	0.21	0.48	0.68	0.84	0.97	1.1	1.2
0.6	0.2	–0.52	1.2	2.7	4.1	5.3	6.4	7.4	8.3	9.1	9.9
	0 3	–0.93	0.06	0.85	1.5	2.1	2.6	3.0	3.4	3.7	4.0
	0.4	–1.1	–0.37	0.16	0.55	0.86	1.1	1.3	1.4	1.6	1.8
	0.5	–1.1	–0.49	–0.06	0.25	0.48	0.66	0.79	0.90	1.0	1.1
	0.6	– 1.2	–0.55	–0.15	0.12	0.31	0.45	0.56	0.65	0.71	0.77

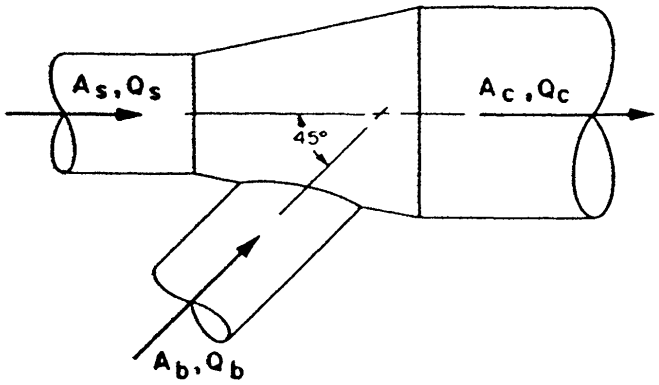
Branch, $C_{c,b}$

		Q_b/Q_c									
A_s/A_c	A_b/A_c	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**
0.8	0.2	–0.27	1.3	2.7	4.0	5.2	6.3	7.3	8.2	9.0	9.7
	0.3	–0.67	0.18	0.90	1.5	2.0	2.5	2.9	3.3	3.6	4.0
	0.4	–0.85	–0.27	0.16	0.49	0.75	0.97	1.2	1.3	1.4	1.6
	0.5	–0.90	–0.40	–0.07	0.18	0.36	0.50	0.61	0.70	0.78	0.84
	0.6	–0.92	–0.46	–0.16	0.04	0.18	0.29	0.37	0.44	0.49	0.53
	0.7	–0.93	–0.49	–0.21	–0.03	0.10	0.19	0.25	0.30	0.34	0.37
	0.8	–0.93	–0.50	–0.24	–0.07	0.05	0.13	0.19	0.23	0.27	0.29
1.0	0.2	–0.26	1.2	2.6	3.9	5.1	6.1	7.1	8.0	8.8	9.5
	0.3	–0.65	0.12	0.79	1.4	1.9	2.4	2.8	3.1	3.5	3.8
	0.4	–0.83	–0.34	0.04	0.33	0.58	0.78	0.95	1.1	1.2	1.3
	0.5	–0.89	–0.48	–0.20	0	0.15	0.27	0.37	0.45	0.51	0.57
	0.6	–0.91	–0.54	–0.31	–0.14	–0.03	0.06	0.12	0.18	0.22	0.25
	0.8	–0.91	–0.59	–0.38	–0.25	–0.16	–0.10	–0.06	–0.03	–0.01	0.01
	1.0	–0.93	–0.60	–0.40	–0.28	–0.20	–0.14	–0.11	–0.08	–0.07	–0.06

Main, $C_{c,s}$

		Q_b/Q_c									
A_s/A_c	A_b/A_c	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**
0.3	0.2	4.5	2.8	1.5	0.56	–0.17	–0.74	–1.2	–1.6	–1.9	–2.1
	0.3	4.6	3.1	2.0	1.2	0.57	0.08	–0.30	–0.62	–0.89	–1.1
0.4	0.2	1.6	0.85	0.16	–0.43	–0.92	–1.3	–1.7	–1.9	–2.2	–2.4
	0.3	1.7	1.1	0.58	0.13	–0.24	–0.56	–0.82	–1.1	–1.3	–1.4
	0.4	1.8	1.3	0.80	0.42	0.11	–0.15	–0.37	–0.55	–0.72	–0.86
0.5	0.2	0.67	0.18	–0.33	–0.79	–1.2	–1.5	–1.8	–2.1	–2.3	–2.5
	0.3	0.75	0.42	0.07	–0.25	–0.54	–0.80	–1.0	–1.2	–1.4	–1.5
	0.4	0.80.	0.55	0.28	0.03	–0.20	–0.40	–0.57	–0.73	–0.86	–0.98
	0.5	0.82	0.62	0.41	0.20	0.02	–0.15	–0.29	–0.42	–0.53	–0.63
0.6	0.2	0.26	–0.11	–0.54	–0.95	–1.3	–1.6	–1.9	–2.1	–2.4	–0.25
	0.3	0.34	0.13	–0.14	–0.42	–0.67	–0.90	–0.11	–0.13	–0.14	–0.16
	0.4	0.39	0.25	0.06	–0.14	–0.33	–0.51	–0.66	–0.80	–0.93	–1.0
	0.5	0.41	0.32	0.18	0.03	–1.2	–0.26	–0.38	–0.50	–0.60	–0.69
	0.6	0.43	0.37	0.26	0.14	0.02	–0.09	–0.19	–0.29	–0.37	–0.45
0.8	0.2	–0.01	–0.30	–0.67	–1.1	–1.4	–1.7	–2.0	–2.2	–2.4	–2.6
	0.3	0.07	–0.07	–0.29	–0.58	–0.76	–0.97	–1.2	–1.3	–1.5	–1.6
	0.4	0.11	0.05	–0.09	–0.26	–0.42	–0.58	–0.72	–0.85	–0.97	–1.1
	0.5	0.14	0.12	0.03	–0.09	–0.21	–0.34	–0.45	–0.55	–0.64	–0.73
	0.6	0.l5	0.17	0.11	0.02	–0.07	–0.17	–0.26	–0.34	–0.42	–0.49
	0.7	0.17	0.21	0.17	0.11	0.03	–0.05	–0.12	–0.19	–0.26	–0.32
	0.5	0.17	0.23	0.22	0.17	0.11	0.05	–0.02	–0.07	–0.13	–0.18
1.0	0.2	–0.05	–0.33	–0.70	–1.1	–1.4	–1.7	–2.0	–2.2	–2.4	–2.6
	0.3	0.03	–0.10	–0.31	–0.55	–0.78	–0.98	–1.2	–1.3	–1.5	–1.6
	0.4	0.07	0.02	–0.12	–0.28	–0.44	–0.59	–0.73	–0.86	–0.98	–1.1
	0.5	0.09	0.09	0.01	–0.11	–0.23	–0.35	–0.46	–0.56	–0.65	–0.74
	0.6	0.11	0.14	0.09	0	–0.09	–0.18	–0.27	–0.35	–0.43	–0.50
	0.8	0.13	0.20	0.19	0.15	0.09	0.03	–0.03	–0.08	–0.14	–0.19
	1.0	0.14	0.24	0.25	0.24	0.20	0.16	0.12	0.08	0.04	0

5-5 Wye, 45°, Converging, Round, Conical Main (Sepsy and Pies 1973)



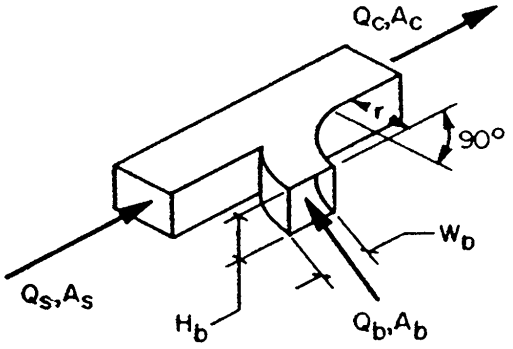
Branch, $C_{c,b}$

		Q_b/Q_s									
A_s/A_c	A_b/A_c	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**
0.3	0.2	–2.4	–0.01	2.0	3.8	5.3	6.6	7.8	8.9	9.8	11
	0.3	–2.8	–1.2	0.12	1.1	1.9	2.6	3.2	3.7	4.2	4.6
0.4	0.2	–1.2	0.93	2.8	4.5	5.9	7.2	8.4	9.5	10	11
	0.3	–1.6	–0.27	0.81	1.7	2.4	3.0	3.6	4.1	4.5	4.9
	0.4	–1.8	–0.72	0.07	0.66	1.1	1.5	1.8	2.1	2.3	2.5
0.5	0.2	–0.46	1.5	3.3	4.9	6.4	7.7	8.8	9.9	11	12
	0.3	–0.94	0.25	1.2	2.0	2.7	3.3	3.8	4.2	4.7	5.0
	0.4	–1.1	–0.24	0.42	0.92	1.3	1.6	1.9	2.1	2.3	2.5
	0.5	–1.2	–0.38	0.18	0.58	0.88	1.1	1.3	1.5	1.6	1.7
0.6	0.2	–0.55	1.3	3.1	4.7	6.1	7.4	8.6	9.6	11	12
	0.3	–1.1	0	0.88	1.6	2.3	2.8	3.3	3.7	4.1	4.5
	0.4	–1.2	–0.48	0.10	0.54	0.89	1.2	1.4	1.6	1.8	2.0
	0.5	–1.3	–0.62	–0.14	0.21	0.47	0.68	0.85	0.99	1.1	1.2
	0.6	–1.3	–0.69	–0.26	0.04	0.26	0.42	0.57	0.66	0.75	0.82
0.8	0.2	0.06	1.8	3.5	5.1	6.5	7.8	8.9	10	11	12
	0.3	–0.52	0.35	1.1	1.7	2.3	2.8	3.2	3.6	3.9	4.2
	0.4	–0.67	–0.05	0.43	0.80	1.1	1.4	1.6	1.8	1.9	2.1
	0.6	–0.75	–0.27	0.05	0.28	0.45	0.58	0.68	0.76	0.83	0.88
	0.7	–0.77	–0.31	–0.02	0.18	0.32	0.43	0.50	0.56	0.61	0.65
	0.8	–0.78	–0.34	–0.07	0.12	0.24	0.33	0.39	0.44	0.47	0.50
1.0	0.2	0.40	2.1	3.7	5.2	6.6	7.8	9.0	11	11	12
	0.3	–0.21	0.54	1.2	1.8	2.3	2.7	3.1	3.7	3.7	4.0
	0.4	–0.33	0.21	0.62	0.96	1.2	1.5	1.7	2.0	2.0	2.1
	0.5	–0.38	0.05	0.37	0.60	0.79	0.93	1.1	1.2	1.2	1.3
	0.6	–0.41	–0.02	0.23	0.42	0.55	0.66	0.73	0.80	0.85	0.89
	0.8	–0.44	–0.10	0.11	0.24	0.33	0.39	0.43	0.46	0.47	0.48
	1.0	–0.46	–0.14	0.05	0.16	0.23	0.27	0.29	0.30	0.30	0.29

Main, $C_{c,s}$

		Q_b/Q_s									
A_s/A_c	A_b/A_c	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**	**12**	**1.4**	**1.6**	**1.8**	**2.0**
0.3	0.2	5.3	–0.01	2.0	1.1	0.34	–0.20	–0.61	–0.93	–1.2	–1.4
	0.3	5.4	3.7	2.5	1.6	1.0	0.53	0.16	–0.14	–0.38	–0.58
0.4	0.2	1.9	1.1	0.46	–0.07	–0.49	–0.83	–1.1	–1.3	–1.5	–1.7
	0.3	2.0	1.4	0.81	0.42	0.08	–0.20	–0.43	–0.62	–0.78	–0.92
	0.4	2.0	1.5	1.0	0.68	0.39	0.16	–0.04	–0.21	–0.35	–0.47
0.5	0.2	0.77	0.34	–0.09	–0.48	–0.81	–1.1	–1.3	–1.5	–1.7	–1.8
	0.3	0.85	0.56	0.25	–0.03	–0.27	–0.48	–0.67	–0.82	–0.96	–1.1
	0.4	0.88	0.66	0.43	0.21	0.02	–0.15	–0.30	–0.42	–0.54	–0.64
	0.5	0.91	0.73	0.54	0.36	0.21	0.06	–0.06	–0.17	–0.26	–0.35
0.6	0.2	0.30	0	–0.34	–0.67	–0.96	–1.2	–1.4	–1.6	–1.8	–1.9
	0.3	0.37	0.21	–0.02	–0.24	–0.44	–0.63	–0.79	–0.93	–1.1	–1.2
	0.4	0.40	0.31	0.16	–0.1	–0.16	–0.30	–0.43	–0.54	–0.64	–0.73
	0.5	0.43	0.37	0.26	0.14	0.02	–0.09	–0.20	–0.29	–0.37	–0.45
	0.6	0.44	0.41	0.33	0.24	0.14	0.05	–0.03	–0.11	–0.18	–0.25
0.8	0.2	–0.06	–0.27	–0.57	–0.86	–1.1	–1.4	–1.6	–1.7	–1.9	–2.0
	0.3	0	–0.08	–0.25	–0.43	–0.62	–0.78	–0.93	–1.1	–1.2	–1.3
	0.4	0.04	0.02	–0.08	–0.21	–0.34	–0.46	–0.57	–0.67	–0.77	–0.85
	0.5	0.06	0.08	0.02	–0.06	–0.16	–0.25	–0.34	–0.42	–0.50	–0.57
	0.6	0.07	0.12	0.09	0.03	–0.04	–0.11	–0.18	–0.25	–0.31	–0.37
	0.7	0.08	0.15	0.14	0.10	0.05	–0.01	–0.07	–0.12	–0.17	–0.22
	0.8	0.09	0.17	0.18	0.16	0.11	0.07	0.02	–0.02	–0.07	–0.11
1.0	0.2	–0.19	–0.39	–0.67	–0.96	–1.2	–1.5	–1.6	–1.8	–2.0	–2.1
	0.3	–0.12	–0.19	–0.35	–0.54	–0.71	–0.87	–1.0	–1.2	–1.3	–1.4
	0.4	–0.09	–0.10	–0.19	–0.31	–0.43	–0.55	–0.66	–0.77	–0.86	–0.94
	0.5	–0.07	–0.04	–0.09	–0.17	–0.26	–0.35	–0.44	–0.52	–0.59	–0.66
	0.6	–0.06	0	–0.02	–0.07	–0.14	–0.21	–0.28	–0.34	–0.40	–0.46
	0.8	–0.04	0.06	0.07	0.05	0.02	–0.03	–0.07	–0.12	–0.16	–0.20
	1.0	–0.3	0.09	0.13	0.13	0.11	0.08	0.06	0.03	–0.01	–0.03

5-6 Tee, Converging, Rectangular (Idelchik 1986, Diagram 7-11)



$r/w_b = 1$

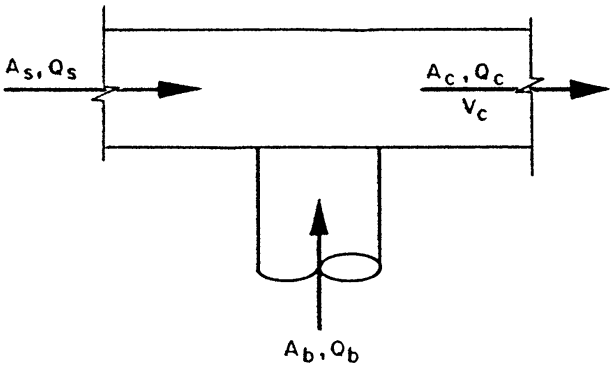
Branch, $C_{c,b}$

		Q_c/Q_c								
A_b/A_s	A_b/A_c	**0.1**	**0.2**	**~0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.33	0.25	–1.2	–0.40	0.40	1.6	3.0	4.8	6.8	8.9	11
0.5	0.5	–0.50	–0.20	0	0.25	0.45	0.70	1.0	1.5	2.0
0.67	0.5	–1.0	–0.60	–0.20	0.10	0.30	0.60	1.0	1.5	2.0
1.0	0.5	–2.2	– 1.5	–0.95	–0.50	0	0.40	0.80	1.3	1.9
1.0	1.0	–0.60	–0.30	–0.10	–0.04	0.13	0.21	0.29	0.36	0.42
1.33	1.0	–1.2	–0.80	–0.40	–0.20	0	0.16	0.24	0.32	0.38
2.0	1.0	–2.1	–1.4	–0.90	–0.50	–0.20	0	0.20	0.25	0.30

Main, $C_{c,s}$

		Q_b/Q_s								
A_b/A_s	A_b/A_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.33	0.25	0.30	0.30	0.20	–0.10	–0.45	–0.92	–1.5	– 2.0	–2.6
0.5	0.5	0.17	0.16	0.10	0	–0.08	–0.18	–0.27	–0.37	–0.46
0.67	0.5	0.27	0.35	0.32	0.25	0.12	–0.03	–0.23	–0.42	–0.58
1.0	0.5	1.2	1.1	0.90	0.65	0.35	0	–0.40	–0.80	–1.3
1.0	1.0	0.18	0.24	0.27	0.26	0.23	0.18	0.10	0	–0.12
1.33	1.0	0.75	0.36	0.38	0.35	0.27	0.18	0.05	–0.08	–0.22
2.0	1.0	0.80	0.87	0.80	0.68	0.55	0.40	0.25	0.08	–0.10

5-7 Tee, Converging, Round Tap to Rectangular Main (SMACNA 1981, Table 6-9C)

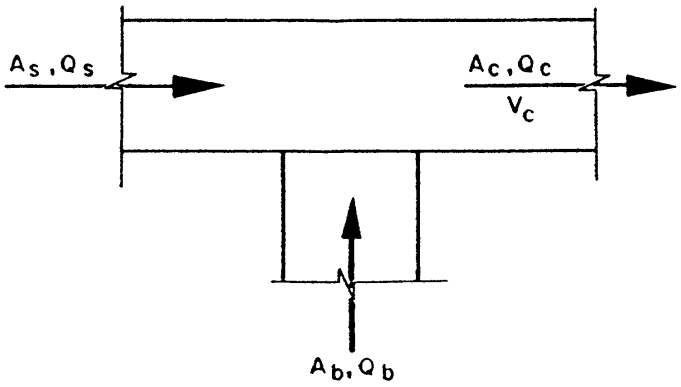


A_b/A_s	A_s/A_c	A_b/A_c
0.5	1.0	0.5

	Branch, $C_{c,b}$									
	Q_b/Q_c									
V_c, fpm	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**
<1200	–0.63	–0.55	0.13	0.23	0.78	1.30	1.93	3.10	4.88	5.60
>1200	–0.49	–0.21	0.23	0.60	1.27	2.06	2.75	3.70	4.93	5.95

For main coefficient ($C_{c,s}$), see Fitting 5-3.

5-8 Tee, Converging, Rectangular Main and Tap (SMACNA 1981, Table 6-9D)

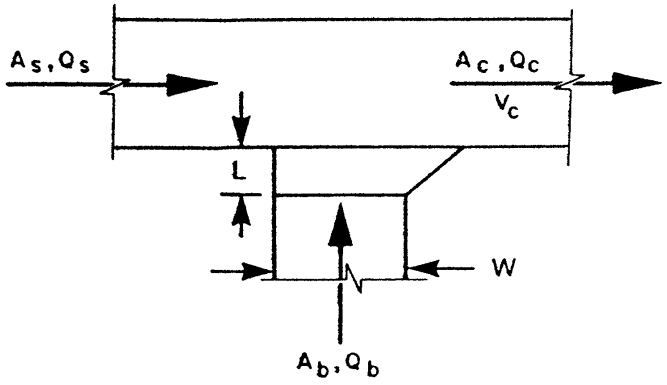


A_b/A_s	A_s/A_c	A_b/A_c
0.5	1.0	0.5

	Branch, $C_{c,b}$									
	Q_b/Q_c									
V_c, fpm	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**
<1200	–0.75	–0.53	–0.03	0.33	1.03	1.10	2.15	2.93	4.18	4.78
>1200.	–0.69	–0.21	0.23	0.67	1.17	1.66	2.67	3.36	3.93	5.13

For main coefficient ($C_{c,s}$), see Fitting 5-3.

5-9 Converging, Rectangular Main and Tap (45° Entry) (SMACNA 1981, Table-9F)



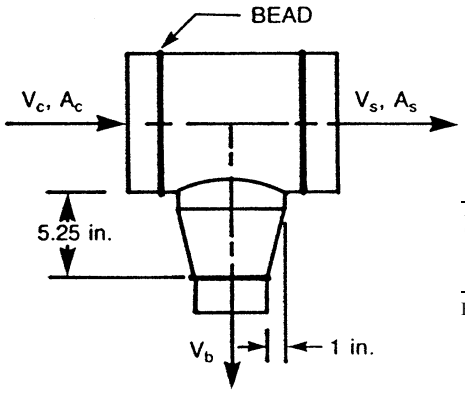
$L = 0.25\ W$, 3 in. min.

A_b/A_s	A_s/A_c	A_b/A_c
0.5	1.0	0.5

	Branch, $C_{c,b}$									
	Q_b/Q_c									
V_c, fpm	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**
<1200	–0.83	–0.68	–0.30	0.28	0.55	1.03	1.50	1.93	2.50	3.03
>1200	–0.72	–0.52	–0.23	0.34	0.76	1.14	1.83	2.01	2.90	3.63

For main coefficient ($C_{c,s}$), see Fitting 5-3.

5-10 Tee, Diverging, Round, Conical Branch (Jones and Sepsy 1969, Figure 12)



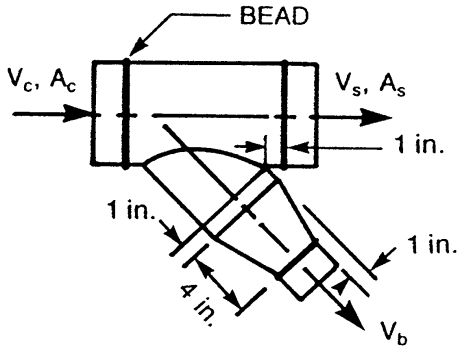
$A_c = A_s$

Branch

V_b/V_s	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	0.85	0.74	0.62	0.52	0.42	0.36	0.32	0.32	0.37	0.52

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-11 Wye, 45°, Diverging, Round, Conical Branch (Jones and Sepsy 1969, Figure 14)



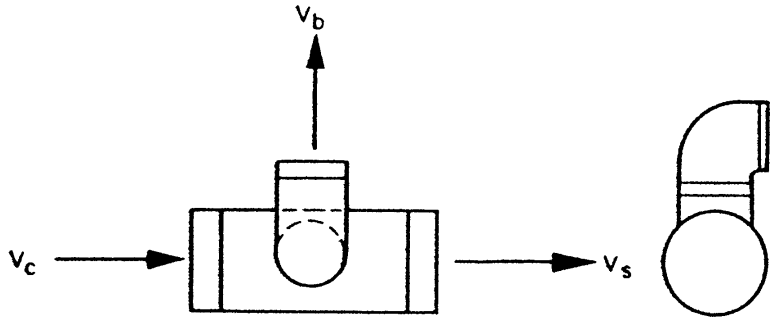
$A_c = A_s$

Branch

V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	0.84	0.61	0.41	0.27	0.17	0.12	0.12	0.14	0.18	0.27

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-12 Tee, Diverging, Round, with 90° Elbow, Branch 90° to Main (Jones and Sepsy 1969, Figure 17)



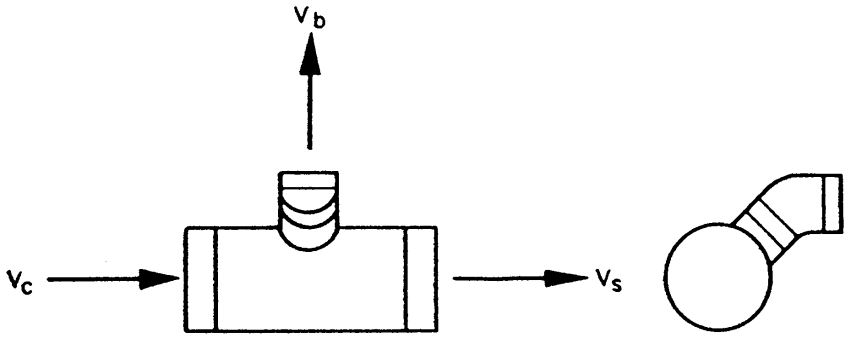
$A_r = A_s$

Branch

V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	1.03	1.08	1.18	1.33	1.56	1.86	2.2	2.6	3.0	3.4

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-13 Tee, Diverging, Round, with 45° Elbow, Branch 90° to Main (Jones and Sepsy 1969, Figure 18)

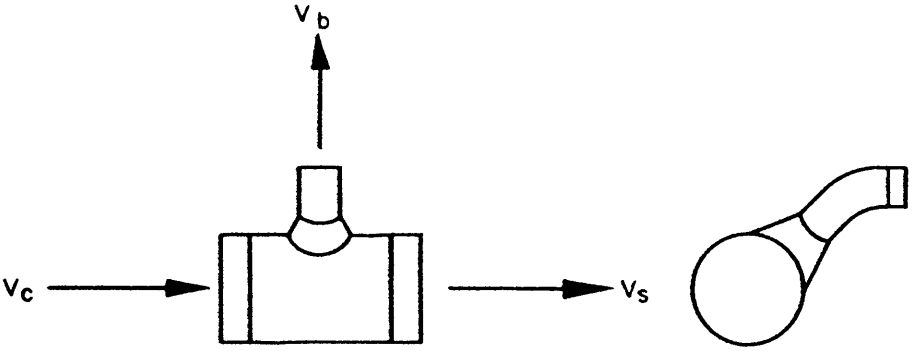


$A_c = A_s$

	Branch										
V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	1.32	1.51	1.60	1.65	1.74	1.87	2.0	2.2	2.5	2.7

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-14 Tee, Diverging, Round (Conical Branch), with 45° Elbow, Branch 90° to Main (Jones and Sepsy 1969, Figure 19)



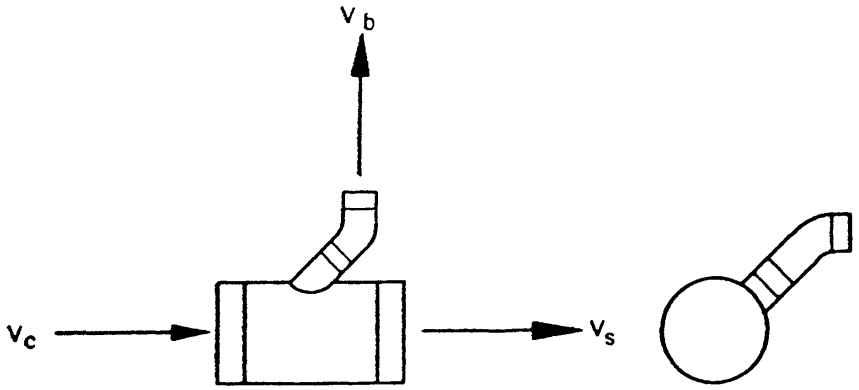
$A_c = A_s$

For tee geometry, see Fitting 5-10.

	Branch										
V_b/V_s	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	0.94	0.88	0.84	0.80	0.82	0.84	0.87	0.90	0.95	1.02

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-15 Wye, 45°, Round, with 60° Elbow, Branch 90° to Main (Jones and Sepsy 1969, Figure 3)

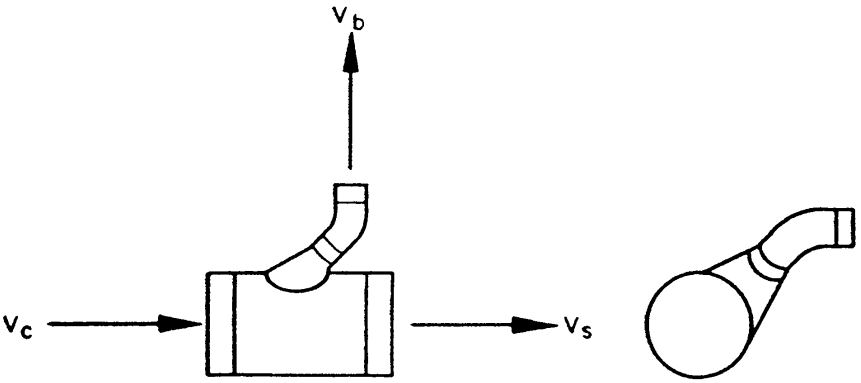


$A_c = A_s$

	Branch										
V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	0.88	0.77	0.68	0.65	0.69	0.73	0.88	1.14	1.54	2.2

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-16 Wye, 45°, Diverging, Round (Conical Branch), with 60° Elbow, Branch 90° to Main (Jones and Sepsy 1969, Figure 20)



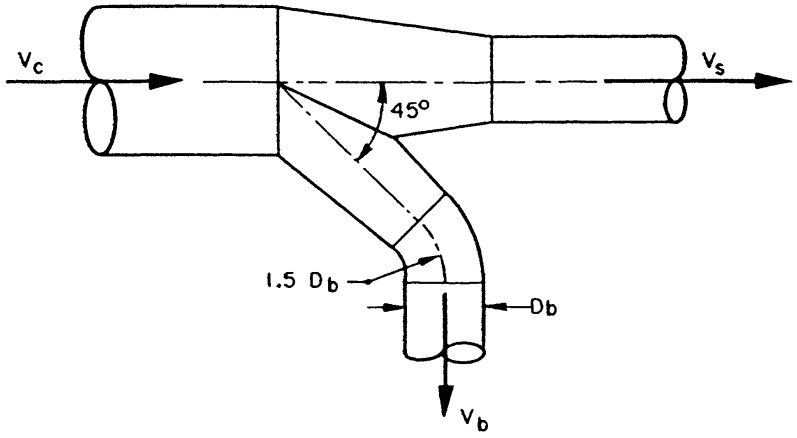
$A_c = A_s$

For wye geometry, see Fitting 5-11.

	Branch										
V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	0.82	0.63	0.52	0.45	0.42	0.41	0.40	0.41	0.45	0.56

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-17 Wye, 48°, Diverging, Conical Main and Branch, with 45° Elbow, Branch 90° to Main
(Idelchik et al. 1986, Diagram 7-19)



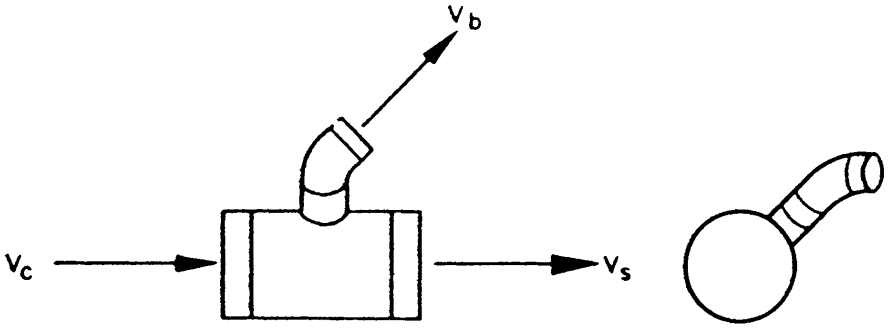
Branch

V_b/V_c	0.2	0.4	0.6	0.7	0.8	0.9	1.0	1.1	1.2
$C_{c,b}$	0.76	0.60	0.52	0.50	0.51	0.52	0.56	0.61	0.68
V_b/V_c	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
$C_{c,b}$	0.86	1.1	1.4	1.8	2.2	2.6	3.1	3.7	4.2

Main

V_s/V_c	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,s}$	0.14	0.06	0.05	0.09	0.18	0.30	0.46	0.64	0.84	1.0

5-18 Tee, Diverging, Round, with 60° Elbow, Branch 45° to Main (Jones and Sepsy 1969, Figure 22)



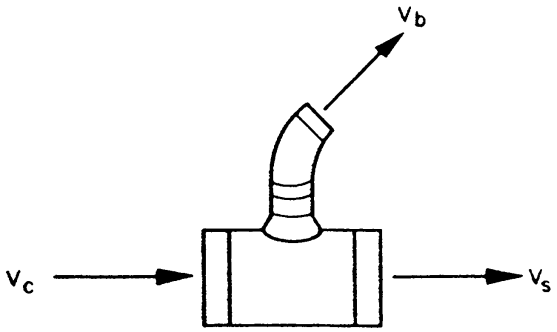
$A_c = A_s$

Branch

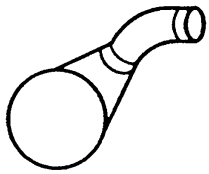
V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	1.06	1.15	1.29	1.45	1.65	1.89	2.2	2.5	2.9	3.3

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-19 Tee, Diverging, Round (Conical Branch), with 60° Elbow, Branch 45° to Main
(Jones and Sepsy 1969, Figure 23)



$A_c = A_s$

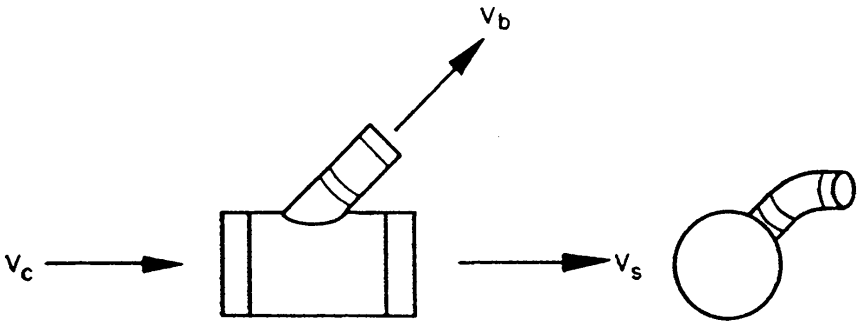


For tee geometry, see Fitting 5-10.

	Branch										
V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c.b}$	1.0	0.95	0.90	0.86	0.81	0.79	0.79	0.81	0.86	0.96	1.10

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-20 Wye, 45°, Diverging, Round, with 30° Elbow, Branch 45° to Main (Jones and Sepsy 1969, Figure 2)

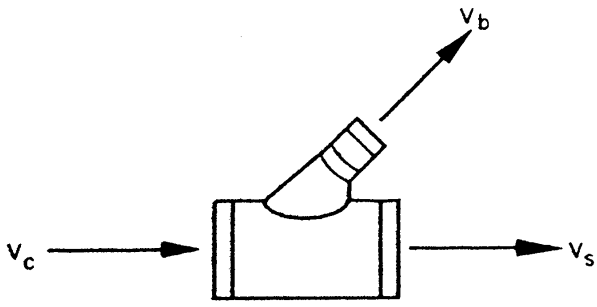


$A_c = A_s$

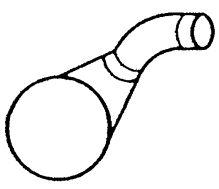
	Branch										
V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	0.84	0.72	0.62	0.54	0.50	0.56	0.71	0.92	1.22	1.66

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-21 Wye, 45°, Diverging, Round (Conical Branch), with 30° Elbow, Branch 45° to Main
(Jones and Sepsy 1969, Figure 24)



$A_c = A_s$



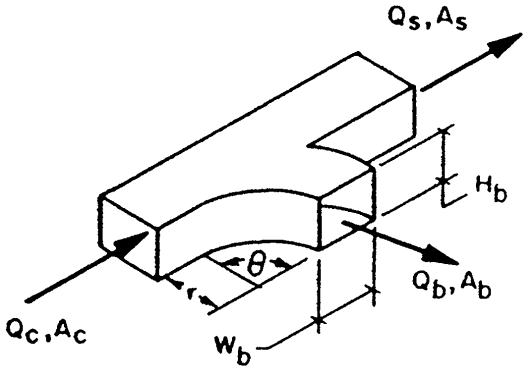
For wye geometry, see Fitting 5-11.

Branch

V_b/V_c	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
$C_{c,b}$	1.0	0.93	0.71	0.55	0.44	0.42	0.42	0.44	0.47	0.54	0.62

For main loss coefficient ($C_{c,s}$), see Fitting 5-23.

5-22 Tee, Diverging, Rectangular (Idelchik et al. 1986, Diagram 7-22)



θ = 90°
r/W_b = 1.0

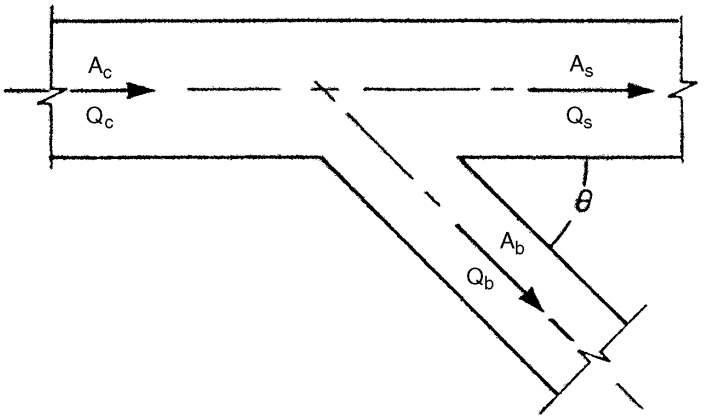
Branch, $C_{c,b}$

		Q_b/Q_c								
A_b/A_s	A_b/A_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.25	0.25	0.55	0.50	0.60	0.85	1.2	1.8	3.1	4.4	6.0
0.33	0.25	0.35	0.35	0.50	0.80	1.3	2.0	2.8	3.8	5.0
0.5	0.5	0.62	0.48	0.40	0.40	0.48	0.60	0.78	1.1	1.5
0.67	0.5	0.52	0.40	0.32	0.30	0.34	0.44	0.62	0.92	1.4
1.0	0.5	0.44	0.38	0.38	0.41	0.52	0.68	0.92	1.2	1.6
1.0	1.0	0.67	0.55	0.46	0.37	0.32	0.29	0.29	0.30	0.37
1.33	1.0	0.70	0.60	0.51	0.42	0.34	0.28	0.26	0.26	0.29
2.0	1.0	0.60	0.52	0.43	0.33	0.24	0.17	0.15	0.17	0.21

Main, $C_{c,s}$

		Q_b/Q_c								
A_b/A_s	A_b/A_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.25	0.25	–0.01	–0.03	–0.01	0.05	0.13	0.21	0.29	0.38	0.46
0.33	0.25	0.08	0	–0.02	–0.01	0.02	0.08	0.16	0.24	0.34
0.5	0.5	–0.03	–0.06	–0.05	0	0.06	0.12	0.19	0.27	0.35
0.67	0.5	0.04	–0.02	–0.04	–0.03	–0.01	0.04	0.12	0.23	0.37
1.0	0.5	0.72	0.48	0.28	0.13	0.05	0.04	0.09	0.18	0.30
1.0	1.0	–0.02	–0.04	–0.04	–0.01	0.06	0.13	0.22	0.30	0.38
1.33	1.0	0.10	0	0.01	–0.03	–0.01	0.03	0.10	0.20	0.30
2.0	1.0	0.62	0.38	0.23	0.23	0.08	0.05	0.06	0.10	0.20

5-23 Wye, Diverging, Rectangular and Round (Idelchik et al. 1986, Diagram 7-21)



$A_c = A_s$

$H_b = H_c$
where H is height of rectangular duct

Main

V_s/V_c	0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0
$C_{c,s}$	0.40	0.32	0.26	0.20	0.14	0.10	0.06	0.02	0

θ = 30°

Branch, $C_{c,b}$

	Q_b/Q_c								
A_b/A_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.8	0.75	0.55	0.40	0.28	0.21	0.16	0.15	0.16	0.19
0.7	0.72	0.51	0.36	0.25	0.18	0.15	0.16	0.20	0.26
0.6	0.69	0.46	0.31	0.21	0.17	0.16	0.20	0.28	0.39
0.5	0.65	0.41	0.26	0.19	0.18	0.22	0.32	0.47	0.67
0.4	0.59	0.33	0.21	0.20	0.27	0.40	0.62	0.92	1.3
0.3	0.55	0.28	0.24	0.38	0.76	1.3	2.0	3.0	4.1
0.2	0.40	0.26	0.58	1.3	2.5	4.1	6.1	8.6	11.0
0.1	0.28	1.5	4.3	8.3	15.0	—	—	—	—

θ = 45°

Branch, $C_{c,b}$

	Q_b/Q_c								
A_b/A_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0 6**	**0.7**	**0.8**	**0.9**
0.8	0.78	0.62	0.49	0.40	0.34	0.31	0.32	0.35	0.40
0.7	0.71	0.59	0.47	0.38	0.34	0.32	0.35	0.41	0.50
0.6	0.74	0.56	0.44	0.37	0.35	0.36	0.43	0.54	0.68
0.5	0.71	0.52	0.41	0.38	0.40	0.45	0.59	0.78	1.0
0.4	0.66	0.47	0.40	0.43	0.54	0.69	0.95	1.3	1.7
0.3	0.66	0.48	0.52	0.73	1.2	1.8	2.7	3.7	4.9
0.2	0.56	0.56	1.0	1.8	3.2	4.9	7.1	9.6	13.0
0.1	0.60	2.1	5.1	9.3	16.0	—	—	—	—

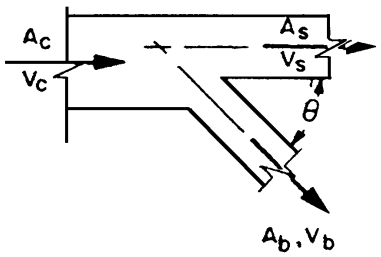
θ = 60°

	Branch, $C_{c,b}$								
	Q_b/Q_c								
A_b/A_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.8	0.83	0.71	0.62	0.56	0.52	0.50	0.53	0.60	0.68
0.7	0.82	0.69	0.61	0.56	0.54	0.54	0.60	0.70	0.82
0.6	0.81	0.68	0.60	0.58	0.58	0.61	0.72	0.87	1.1
0.5	0.79	0.66	0.61	0.62	0.68	0.76	0.94	1.2	1.5
0.4	0.76	0.65	0.65	0.74	0.89	1.1	1.4	1.8	2.3
0.3	0.80	0.75	0.89	1.2	1.8	2.6	3.5	4.6	6.0
0.2	0.77	0.96	1.6	2.5	4.0	6.0	8.3	11.0	—
0.1	1.0	2.9	6.2	10.0	—	—	—	—	—

θ = 90°

	Branch, $C_{c,b}$								
	Q_b/Q_c								
A_b/A_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0 8	0.95	0.92	0.92	0.93	0.94	0.95	1.1	1.2	1.4
0.7	0.95	0.94	0.95	0.98	1.0	1.1	1.2	1.4	1.6
0.6	0.96	0.97	1.0	1.1	1.1	1.2	1.4	1.7	2.0
0.5	0.97	1.0	1.1	1.2	1.4	1.5	1.8	2.1	2.5
0.4	0.99	1.1	1.3	1.5	1.7	2.0	2.4	3.0	3.6
0.3	1.1	1.4	1.8	2.3	3.2	4.3	5.5	6.9	8.5
0.2	1.3	1.9	2.9	4.1	6.2	8.5	11.0	—	—
0.1	2.1	4.8	8.9	14.0	—	—	—	—	—

5-24 Diverging Wye, Rectangular (Idelchik et al. 1986, Diagram 7-22)



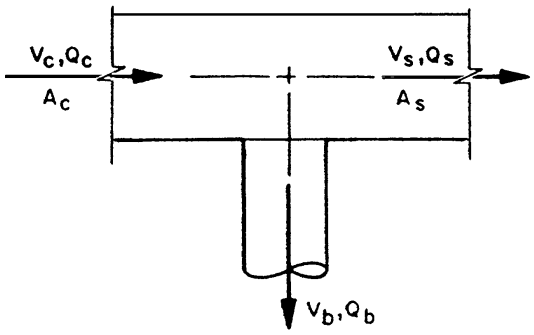
θ = 15° to 90°
and
$A_c = A_s + A_b$

	Branch, $C_{c,b}$												
	V_b/V_c												
θ, deg.	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.8**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**
15	0.81	0.65	0.51	0.38	0.28	0.20	0.11	0.06	0.14	0.30	0.51	0.76	1.0
30	0.84	0.69	0.56	0.44	0.34	0.26	0.19	0.15	0.15	0.30	0.51	0.76	1.0
45	0.87	0.74	0.63	0.54	0.45	0.38	0.29	0.24	0.23	0.30	0.51	0.76	1.0
60	0.90	0.82	0.79	0.66	0.59	0.53	0.43	0.36	0.33	0.39	0.51	0.76	1.0
90	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Main, $C_{c,s}$

θ, degrees	15-60	90				
	A_s/A_c	A_s/A_c				
V_s/V_c	0-1.0	0-0.4	0.5	0.6	0.7	≥0.8
0	1.0	1.0	1.0	1.0	1.0	1.0
0.1	0.81	0.81	0.81	0.81	0.81	0.81
0.2	0.64	0.64	0.64	0.64	0.64	0.64
0.3	0.50	0.50	0.52	0.52	0.50	0.50
0.4	0.36	0.36	0.40	0.38	0.37	0.36
0.5	0.25	0.25	0.30	0.28	0.27	0.25
0.6	0.16	0.16	0.23	0.20	0.18	0.16
0.8	0.04	0.04	0.17	0.10	0.07	0.04
1.0	0	0	0.20	0.10	0.05	0
1.2	0.07	0.07	0.36	0.21	0.14	0.07
1.4	0.39	0.39	0.79	0.59	0.39	—
1.6	0.90	0.90	1.4	1.2	—	—
1.8	1.8	1.8	2.4	—	—	—
2.0	3.2	3.2	4.0	—	—	—

5-25 Tee, Diverging, Rectangular Main to Round Tap (SMACNA 1981, Table 6-10T)



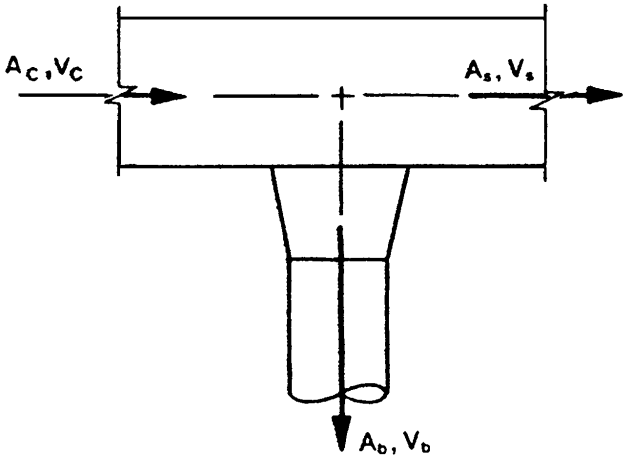
$A_c = A_s$

Branch, $C_{c,b}$

	Q_b/Q_s								
V_b/V_c	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.2	1.00								
0.4	1.01	1.07							
0.6	1.14	1.10	1.08						
0.8	1.18	1.31	1.12	1.13					
1.0	1.30	1.38	1.20	1.23	1.26				
1.2	1.46	1.58	1.45	1.31	1.39	1.48			
1.4	1.70	1.82	1.65	1.51	1.56	1.64	1.71		
1.6	1.93	2.06	2.00	1.85	1.70	1.76	1.80	1.88	
1.8	2.06	2.17	2.10	2.13	2.06	1.98	1.99	2.00	2.07

For main coefficient ($C_{c,s}$), see Fitting 5-23.

5-26 Tee, Diverging, Rectangular Main to Round Tap (Conical) (Inoue et al. 1980, Korst et al. 1950)

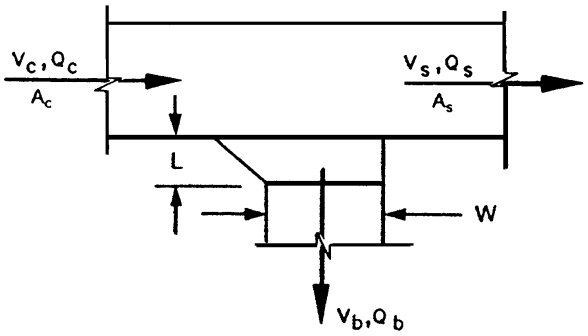


$A_c = A_s$

	Branch					
V_b/V_c	0.40	0.50	0.75	1.0	1.3	1.5
$C_{c,b}$	0.80	0.83	0.90	1.0	1.1	1.4

For main coefficient ($C_{c,s}$), see Fitting 5-23.

5-27 Tee, Diverging, Rectangular Main, and Tap (45° Entry) (SMACNA 1981, Table 6-10N)



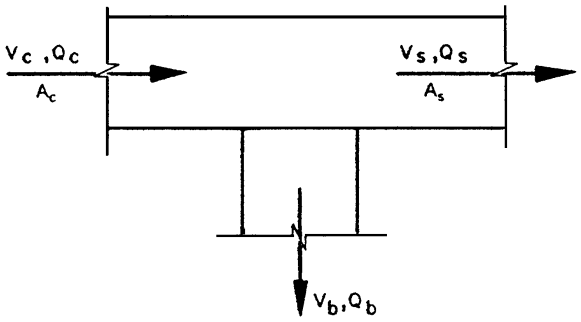
$L = 0.25W$, 3 in. min.
$A_c = A_s$

sRecommended[a]

	Branch, $C_{c,b}$								
	Q_b/Q_s								
V_b/V_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.2	0.91								
0.4	0.81	0.79							
0.6	0.77	0.72	0.70						
0.8	0.78	0.73	0.69	0.66					
1.0	0.78	0.98	0.85	0.79	0.74				
1.2	0.90	1.11	1.16	1.23	1.03	0.86			
1.4	1.19	1.22	1.26	1.29	1.54	0.25	0.92		
1.6	1.35	1.42	1.55	1.59	1.63	1.50	1.31	1.09	
1.8	1.44	1.50	1.75	1.74	1.72	2.24	1.63	1.40	1.17

For main coefficient ($C_{c,s}$), see Fitting 5-23.
[a]For performance study, see SMACNA (1987).

5-28 Tee, Diverging, Rectangular Main, and Tap[a] (SMACNA 1981, Table 10Q)



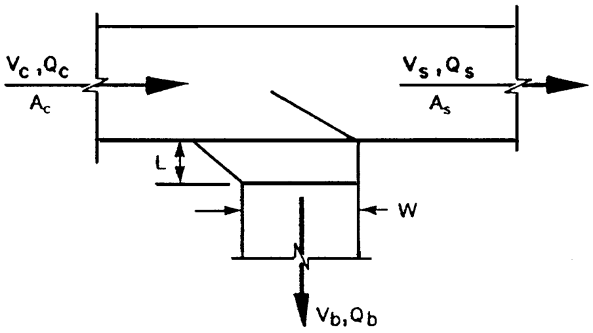
$A_c = A_s$

Branch, $C_{c,b}$

	Q_b/Q_c								
V_b/V_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.2	1.03								
0.4	1.04	1.01							
0 6	1.11	1.03	1.05						
0 8	1.16	1.21	1.17	1.12					
1.0	1.38	1.40	1.30	1.36	1.27				
1 2	1.52	1.61	1.68	1.91	1.47	1.66			
1 4	1.79	2.01	1.90	2.31	2.28	2.20	1.95		
1.6	2.07	2.28	2.13	2.71	2.99	2.81	2.09	2.20	
1.8	2.32	2.54	2.64	3.09	3.72	2.48	2.21	2.57	2.32

For main coefficient ($C_{c,s}$) see Fitting 5-23.
[a]For performance study see SMACNA (1987).

5-29 Tee, Diverging, Rectangular Main and Tap (45° Entry), with Damper (SMACNA 1981, Table 6-10P)



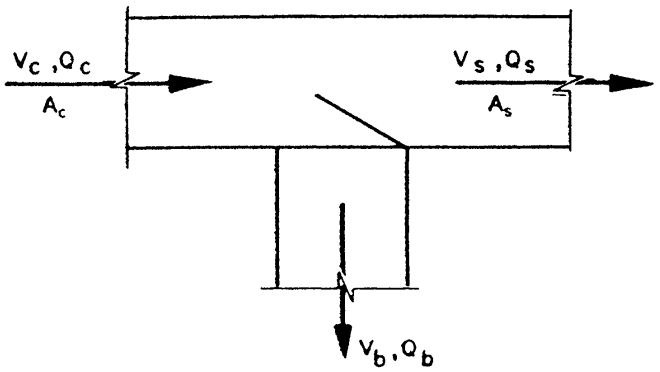
$L = 0.25W$, 3 in. min
$A_c = A_s$

Poor; should not be used.[a]

	Branch, $C_{c,b}$								
	Q_b/Q_c								
V_b/V_c	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.2	0.61								
0.4	0.46	0.61							
0.6	0.43	0.50	0.54						
0.8	0.39	0.43	0.62	0.53					
1.0	0.34	0.57	0.77	0.73	0.68				
1.2	0.37	0.64	0.85	0.98	1.07	0.83			
1.4	0.57	0.71	1.04	1.16	1.54	1.36	1.18		
1.6	0.89	1.08	1.28	1.30	1.69	2.09	1.81	1.47	
1.8	1.33	1.34	2.04	1.78	1.90	2.40	2.77	2.23	1.92

For main coefficient ($C_{c,s}$), see Fitting 5-31.
[a]For performance study, see SMACNA (1987).

5-30 Tee, Diverging, Rectangular Main and Tap, with Damper (SMACNA 1981, Table 6-10R)



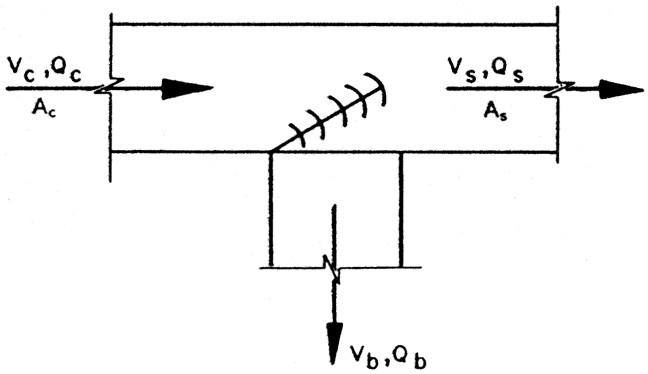
$A_c = A_s$

Poor; should not be used.[a]

	Branch, $C_{c,b}$								
	Q_b/Q_c								
V_b/V_c	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.2	0.58								
0.4	0.67	0.64							
0.6	0.78	0.76	0.75						
0.8	0.88	0.98	0.81	1.01					
1.0	1.12	1.05	1.08	1.18	1.29				
1.2	1.49	1.48	1.40	1.51	1.70	1.91			
1.4	2.10	2.21	2.25	2.29	2.32	2.48	2.53		
1.6	2.72	3.30	2.84	3.09	3.30	3.19	3.29	3.16	
1.8	3.42	4.58	3.65	3.92	4.20	4.15	4.14	4.10	4.05

For main coefficient ($C_{c,s}$) see Fitting 5-31.
[a]For performance study see SMACNA (1987).

5-31 Tee, Diverging, Rectangular, with Extractor (SMACNA 1981, Table 6-10S)



$A_c = A_s$

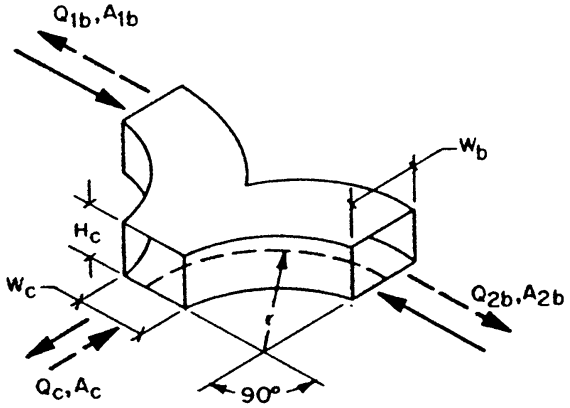
Poor; should not be used.[a]

	Main								
V_b/V_c	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
$C_{c,s}$	0.03	0.04	0.07	0.12	0.13	0.14	0.27	0.30	0.25

	Branch, $C_{c,b}$								
	Q_b/Q_c								
V_b/V_c	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.2	0.60								
0.4	0.62	0.69							
0.6	0.74	0.80	0.82						
0.8	0.99	1.10	0.95	0.90					
1.0	1.48	1.12	1.41	1.24	1.21				
1.2	1.91	1.33	1.43	1.52	1.55	1.64			
1.4	2.47	1.67	1.70	2.04	1.86	1.98	2.47		
1.6	3.17	2.40	2.33	2.53	2.31	2.51	3.13	3.25	
1.8	3.85	3.37	2.89	3.23	3.09	3.03	3.30	3.74	4.11

[a]For performance study, see SMACNA (1987).

5-32 Symmetrical Wye, Dovetail, Rectangular (Idelchik et al. 1986, Diagram 7-24)

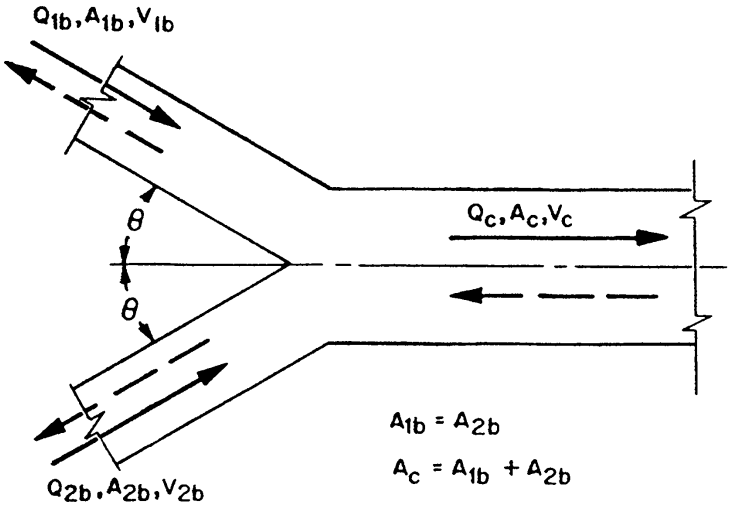


$r/W_c = 1.5$
$Q_{1b}/Q_c = Q_{2b}/Q_c = 0.5$

Converging		
A_{1b}/A_c or A_{2b}/A_c	0.50	1.0
$C_{c,1b}$ or $C_{c,2b}$	0.23	0.07

Diverging		
A_{1b}/A_c or A_{2b}/A_c	0.50	1.0
$C_{c,1b}$ or $C_{c,2b}$	0.30	0.25

5-33 Wye, Rectangular and Round (Idelchik et al. 1986, Diagram 7-30)



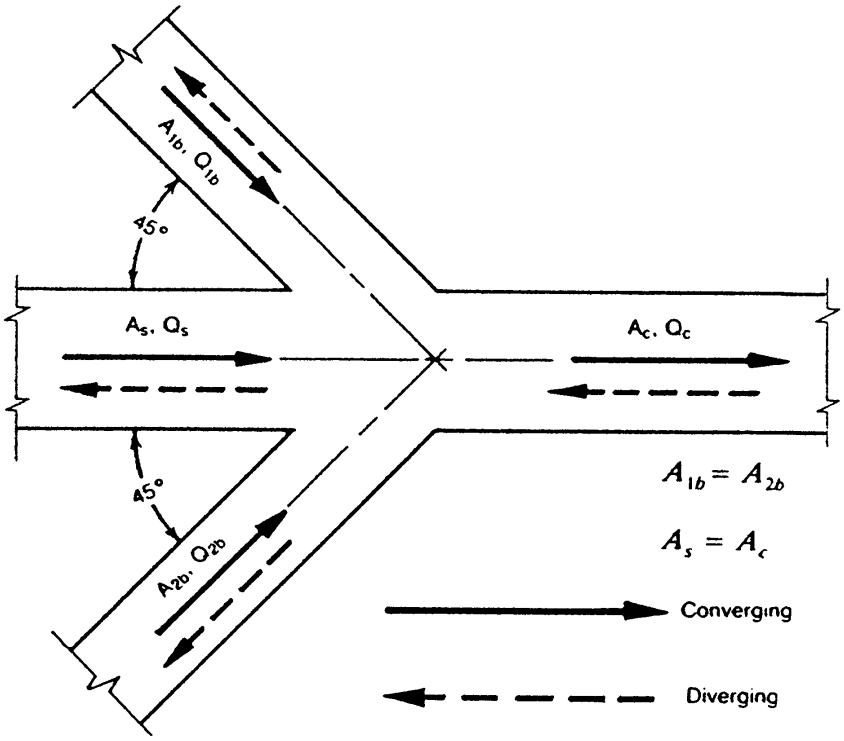
Converging $C_{c,1b}$ or $C_{c,2b}$

	Q_{1b}/Q_c or Q_{2b}/Q_c										
θ, deg.	**0**	**0.1**	**0.2**	**03**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**
15	–2.6	–1.9	–1.3	–0.77	–0.30	0.10	0.41	0.67	0.85	0.97	1.0
30	–2.1	–1.5	–1.0	–0.53	–0.10	0.28	0.69	0.91	1.1	1.4	1.6
45	–1.3	–0.93	–0.55	–0.16	0.20	0.56	0.92	1.3	1.6	2.0	2.3

Diverging $C_{c,1b}$ or $C_{c,2b}$

	V_{1b}/V_c or V_{2b}/V_c												
θ, deg.	**0.1**	**0.2**	**03**	**0.4**	**0.5**	**0.6**	**0.8**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**
15	0.81	0.65	0.51	0.38	0.28	0.20	0.11	0.06	0.14	0.30	0.51	0.76	1.0
30	0.84	0.69	0.56	0.44	0.34	0.26	0.19	0.15	0.15	0.30	0.51	0.76	1.0
45	0.87	0.74	0.63	0.54	0.45	0.38	0.29	0.24	0.23	0.30	0.51	0.76	1.0
60	0.90	0.82	0.79	0.66	0.59	0.53	0.43	0.36	0.33	0.39	0.51	0.76	1.0
90	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

5-34 Wye (Double), 45° Rectangular and Round (Idelchik et al. 1986, Diagram 7-27)



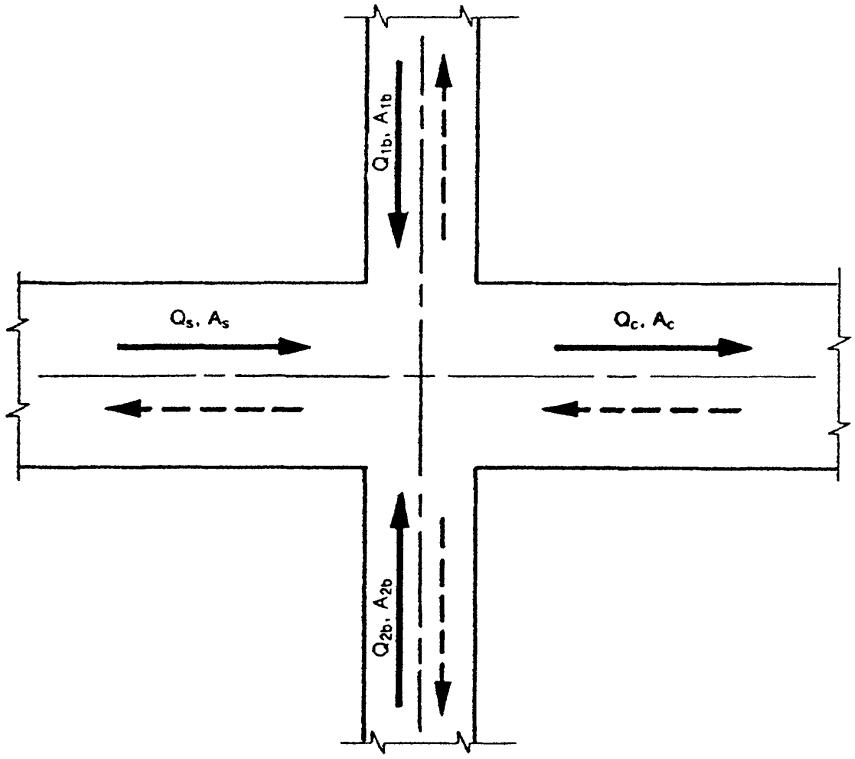
Converging Flow

	Branch, $C_{c,b}$						
	Q_{1b}/Q_c						
Q_{2b}/Q_{1b}	**0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
				A_{1b}/A_c **= 0.2**			
0.5	–1.0	–0.36	0.59	1.8	3.2	4.9	6.8
1.0	–1.0	–0.24	0.63	1.7	2.6	3.7	—
2.0	–1.0	–0.19	0.21	0.04	—	—	—
				A_{1b}/A_c **= 0.4**			
0.5	–1.0	–0.48	–0.02	0.58	0.92	1.3	16
1.0	–1.0	–0.36	0.17	0.55	0.72	0.78	—
2.0	–1.0	–0.18	0.16	–0.06	—	—	—
				A_{1b}/A_c **= 0.6**			
0.5	–1.0	–0.50	–0.07	0.31	0.60	0.82	0.92
1.0	–1.0	–0.37	0.12	0.55	0.60	0.52	—
2.0	–1.0	–0.18	0.26	0.16	—	—	—
				A_{1b}/A_c **= 1.0**			
0.5	–1.0	–0.51	–0.09	0.25	0.50	0.65	0.64
1.0	–1.0	–0.37	0.13	0.46	0.61	0.54	—
2.0	–1.0	–0.15	0.38	0.42	—	—	—

	Main, $C_{c,s}$										
	Q_s/Q_c										
Q_{2b}/Q_{1b}	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
					A_{1b}/A_c = 0.2						
0.5 & 2.0	–2.9	–1.9	–1.3	–0.80	–0.56	–0.23	–0.01	0.16	0.22	0.15	0
1.0	–2.5	–1.9	–1.3	–0.80	–0.42	–0.12	0.08	0.20	0.22	0.15	0
					A_{1b}/A_c = 0.4						
0.5 & 2.0	–0.98	–0.61	–0.30	–0.05	0.14	0.26	0.33	0.34	0.28	0.17	0
1.0	–0.77	–0.44	–0.16	0.05	0.21	0.31	0.36	0.35	0.29	0.17	0
					A_{1b}/A_c = 0.6						
0.5 & 2.0	–0.32	0.08	0.11	0.27	0.37	0.43	0.44	0.40	0.31	0.18	0
1.0	–0.18	–0.04	0.21	0.34	0.42	0.46	0.46	0.41	0.31	0.18	0
					A_{1b}/A_c = 1.0						
0.5 & 2.0	0.11	0.36	0.46	0.53	0.57	0.56	0.52	0.44	0.33	0.18	0
1.0	0.29	0.42	0.51	0.57	0.58	0.58	0.54	0.45	0.33	0.18	0

Diverging Flow: Use Fitting 5-23.

5-35 Cross, 90°, Rectangular and Round (Idelchik et al. 1986, Diagram 7-29)



$A_{1b} = A_{2b}$
$A_s = A_c$

Converging Flow

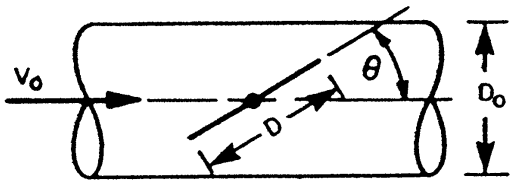
	Branch, $C_{c,b}$						
	Q_{1b}/Q_c or Q_{2b}/Q_c						
Q_{2b}/Q_{1b}	**0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
				A_{1b}/A_c = **0.2**			
0.5	–0.85	–0.10	1.1	2.7	4.8	7.3	10
1.0	–0.85	–0.05	1.4	3.1	5.1	7.4	—
2.0	–0.85	–0.31	1.8	3.4	—	—	—
				A_{1b}/A_c = **0.4**			
0.5	–0 85	–0.29	0.34	1.0	1.8	2.6	3.4
1.0	–0.85	–0.14	0.60	1.3	2.1	2.7	—
2.0	–0.85	0.12	1.0	1.7	—	—	—
				A_{1b}/A_c = **0.6**			
0.5	–0.85	–0.32	0.20	0.72	1.2	1.7	2.1
1.0	–0.85	–0.18	0.46	1.0	1.5	1.9	—
2.0	–0.85	0.09	0.88	1.4	—	—	—
				A_{1b}/A_c = **0.8**			
0.5	–0.85	–0.33	0.13	0.61	1.0	1.4	1.7
1.0	–0.85	–0.18	0.41	0.91	1.3	1.5	—
2.0	–0.85	0.08	0.83	1.3	—	—	—
				A_{1b}/A_c = **1.0**			
0.5	–0.85	–0.34	0.13	0.56	0.93	1.3	1.5
1.0	–0.85	–0.19	0.39	0.86	1.2	1.4	—
2.0	–0.85	0.07	0.81	1.2	—	—	—

	Main					
Q_s/Q_c	0	0.1	0.2	0.3	0.4	0.5
$C_{c,s}$	1.2	1.2	1.2	1.1	1.1	0.96
Q_s/Q_c	0.6	0.7	0.8	0.9	1.0	
$C_{c,s}$	0.85	0.72	0.56	0.39	0.20	

Diverging Flow: Use Fitting 5-23.

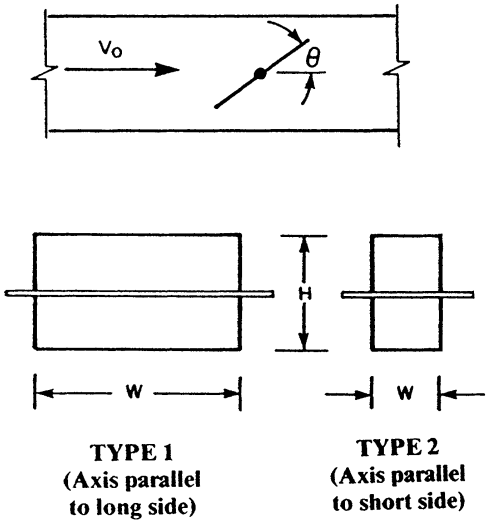
6 OBSTRUCTIONS

6-1 Damper, Butterfly, Round (Idelchik et al. 1986, Diagram 9-16; Zolotov 1967)



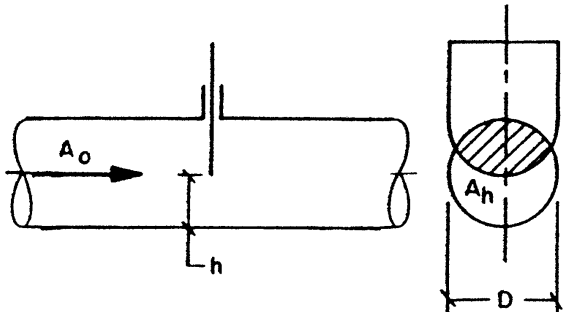
	C_o										
	θ, degrees										
D/D_o	0	10	20	30	40	50	60	70	75	80	85
0.5	019	0.27	0.37	0.49	0.61	0.74	0.86	0.96	0.99	1.0	1.0
0.6	0.19	0.32	0.48	0.69	0.94	1.2	1.5	1.7	1.8	1.9	1.9
0.7	0.19	0.37	0.64	1.0	1.5	2.1	2.8	3.5	3.7	3.9	4.1
0.8	0.19	0.45	0.87	1.6	2.6	4.1	6.1	8.4	9.4	10	10
0.9	0.19	0.54	1.2	2.5	5.0	9.6	17	30	38	45	50
1.0	0.19	0.67	1.8	4.4	11	32	113	—	—	—	—

6-2 Damper, Butterfly, Rectangular (Idelchik et al. 1986, Diagram 9-17; Zolotov 1967)



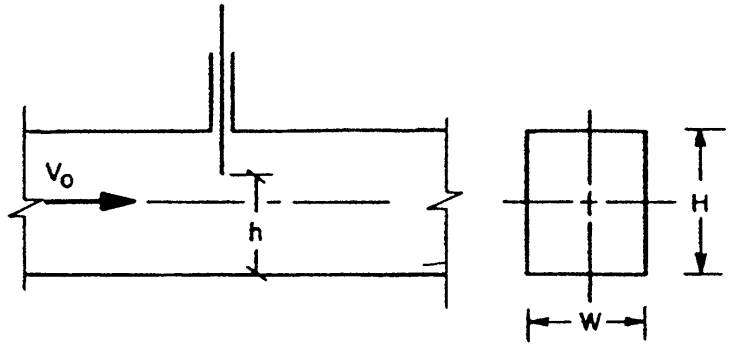
		C_o								
		θ, degrees								
Type	H/W	0	10	20	30	40	50	60	65	70
1	<0.25	0.04	0.30	1.1	3.0	8.0	23	60	100	190
1	0.25-1.0	0.08	0.33	1.2	3.3	9.0	26	70	128	210
2	>1.0	0.13	0.35	1.3	3.6	10	29	80	155	230

6-3 Damper, Gate, Round (Idelchik et al. 1986, Diagram 9-5)



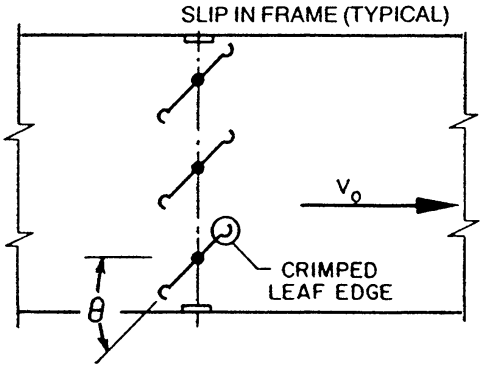
h/D	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
A_h/A_o	0.25	0.38	0.50	0.61	0.71	0.81	0.90	0.96
C_o	35	10	4.6	2.1	0.98	0.44	0.17	0.06

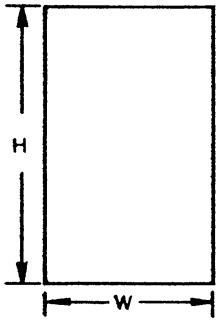
6-4 Damper, Gale, Rectangular (Idelchik et al. 1986, Diagram 8-5)



				h/H			
H/W	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0.5	14	6.9	3.3	1.7	0.83	0.32	0.09
1.0	19	8.8	4.5	2.4	1.2	0.55	0.17
1.5	20	9.1	4.7	2.7	1.2	0.47	0.11
2.0	18	8.8	4.5	2.3	1.1	0.51	0.13

6-5 Damper, Rectangular, Parallel Blades (Brown and Fellows 1957)



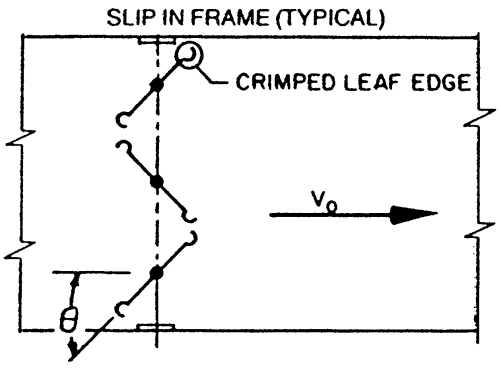


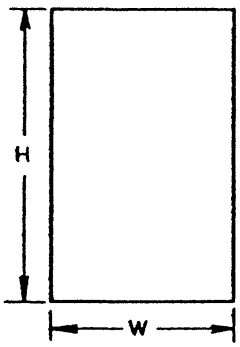
$$L/R = \frac{NW}{2(H+W)}$$

where
N = number of damper blades
W = duct dimension parallel tc blade axis, in.
H = duct height, in.
L = sum of damper blade lengths, in.
R = perimeter of duct, in.

				C_o				
	θ, degrees							
L/R	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**
0.3	0.52	0.79	1.4	2.3	5.0	9	14	32
0.4	0.52	0.85	1.5	2.4	5.0	9	16	38
0.5	0.52	0.92	1.5	2.4	5.0	9	18	45
0.6	0.52	0.92	1.5	2.4	5.4	9	21	45
0.8	0.52	0.92	1.5	2.5	5.4	9	22	55
1.0	0.52	1.0	1.6	2.6	5.4	10	24	65
1.5	0.52	1.0	1.6	2.7	5.4	10	28	102

6-6 Damper, Rectangular, Opposed Blades (Brown and Fellows 1957)



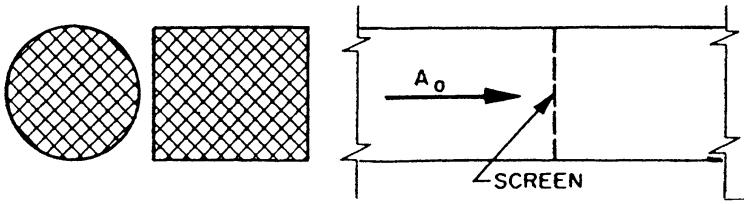


$$L/R = \frac{NW}{2(H+W)}$$

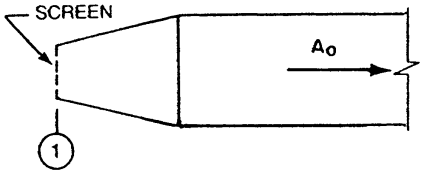
See Fitting 6-5 for definition of terms.

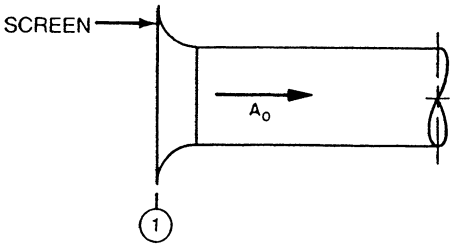
	C_o							
	θ, degrees							
L/R	0	10	20	30	40	50	60	70
0.3	0.52	0.85	2.1	4.1	9	21	73	284
0.4	0.52	0.92	2.2	5.0	11	28	100	332
0.5	0.52	1.0	2.3	5.4	13	33	122	377
0.6	0.52	1.0	2.3	6.0	14	38	148	411
0.8	0.52	1.1	2.4	6.6	18	54	188	495
1.0	0.52	1.2	2.7	7.3	21	65	245	547
1.5	0.52	1.4	3.2	9.0	28	107	361	677

6-7 Obstruction, Screen, Round and Rectangular (Idelchik et al. 1986, Diagram 8-6)



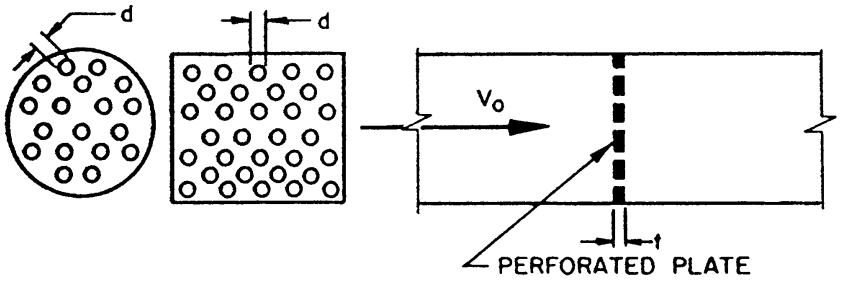
n = free area ratio of screen
A_o = area of duct
A_1 = cross-sectional area of duct or fitting where screen is located





	C_o							
	n							
A_1/A_o	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.2	155	75	42	24	15	8.0	3.5	0
0.3	69	33	19	11	6.4	3.6	1.6	0
0.4	39	19	10	6.1	3.6	2.0	0.88	0
0.6	17	8.3	4.7	2.7	1.6	0.89	0.39	0
0.8	9.7	4.7	2.7	1.5	0.91	0.50	0.22	0
1.0	6.2	3.0	1.7	0.97	0.58	0.32	0.14	0
1.2	4.3	2.1	1.2	0.67	0.40	0.22	0.10	0
1.4	3.2	1.5	0.87	0.49	0.30	0.16	0.07	0
1.6	2.4	1.2	0.66	0.38	0.23	0.12	0.05	0
2.0	1.6	0.75	0.43	0.24	0.15	0.08	0.04	0
2.5	0.99	0.48	0.27	0.16	0.09	0.05	0.02	0
3.0	0.69	0.33	0.19	0.11	0.06	0.04	0.02	0
4.0	0.39	0.19	0.11	0.06	0.04	0.02	0.01	0
6.0	0.17	0.08	0.05	0.03	0.02	0.01	0	0

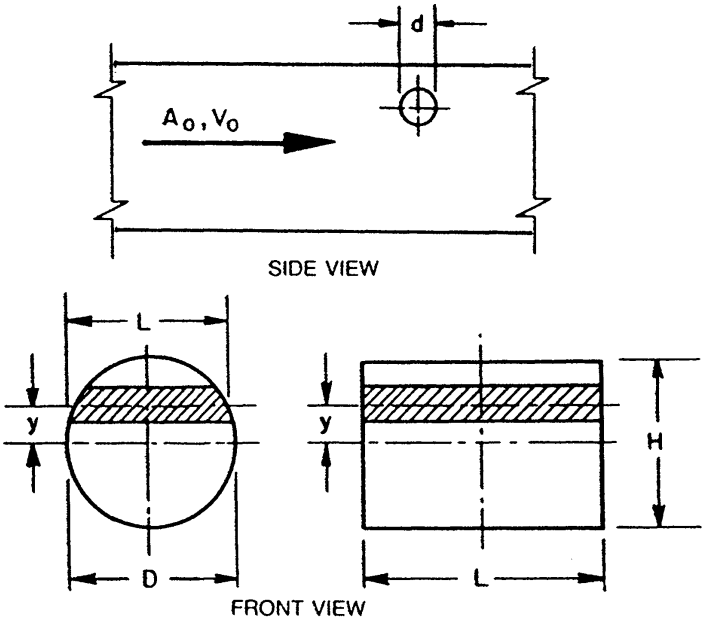
6-8 Obstruction, Perforated Plate, Thick, Round, and Rectangular (Idelchik et al. 1986, Diagram 8-6)



C_o									
	n								
t/d	0.20	0.25	0.30	0.40	0.50	0.60	0.70	0.80	0.90
0.015	52	30	18	8.3	4.0	2.0	0.97	0.42	0.13
0.2	48	28	17	7.7	3.8	1.9	0.91	0.40	0.13
0.4	46	27	17	7.4	3.6	1.8	0.88	0.39	0.13
0.6	42	24	15	6.6	3.2	1.6	0.80	0.36	0.13

$t/d \geq 0.015$
$A_{or} = \pi d^2/4$
$n = \Sigma A_{or}/A_o$
where
A_o = area of duct
A_{or} = orifice area
d = diameter of perforated hole
n = free area ratio of plate, dimensionless
t = plate thickness

6-9 Obstruction, Smooth Cylinder in Round and Rectangular Ducts (Idelchik et al. 1986, Diagram 10-1)



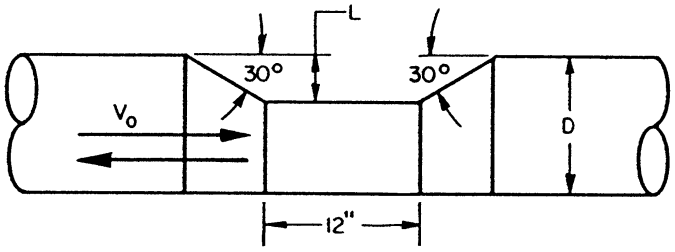
$S_m/A_o < 0.3$
$S_m = dL$
$\mathrm{Re}' = dV_o/v$
$C_o = KC'_o$

C'_o				
	S_m/A_o			
Re′	0.05	0.10	0.15	0.20
0.1	3.9	8.4	14	19
0.5	1.5	3.2	5.2	7.1
1	0.66	1.4	2.3	3.2
5	0.30	0.64	1.1	1.4
10	0.17	0.38	0.62	0.84
50	0.11	0.24	0.38	0.52
100	0.10	0.21	0.35	0.47
500 to 200,000	0.07	0.15	0.24	0.33
3×10^5	0.07	0.16	0.26	0.35
4×10^5	0.05	0.11	0.19	0.25
5×10^5	0.04	0.09	0.14	0.19
6×10^5 to 10^6	0.02	0.05	0.07	0.10

For obstruction offset from the centerline, use the following factors:

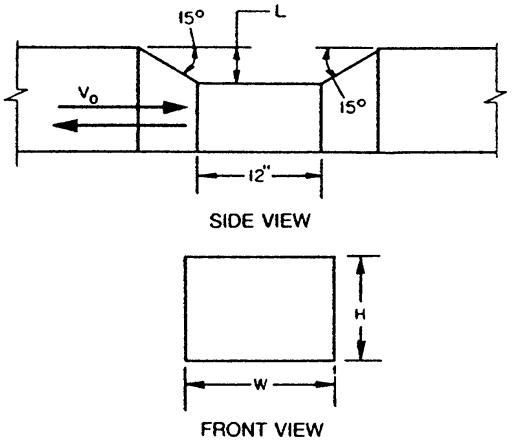
y/D or y/H	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
K	1.0	0.97	0.93	0.89	0.84	0.79	0.74	0.67	0.58

6-10 Round Duct, Depressed to Avoid an Obstruction (SMACNA 1981,Table 6-14I)



$L/D = 0.33$
$C_o = 0.24$

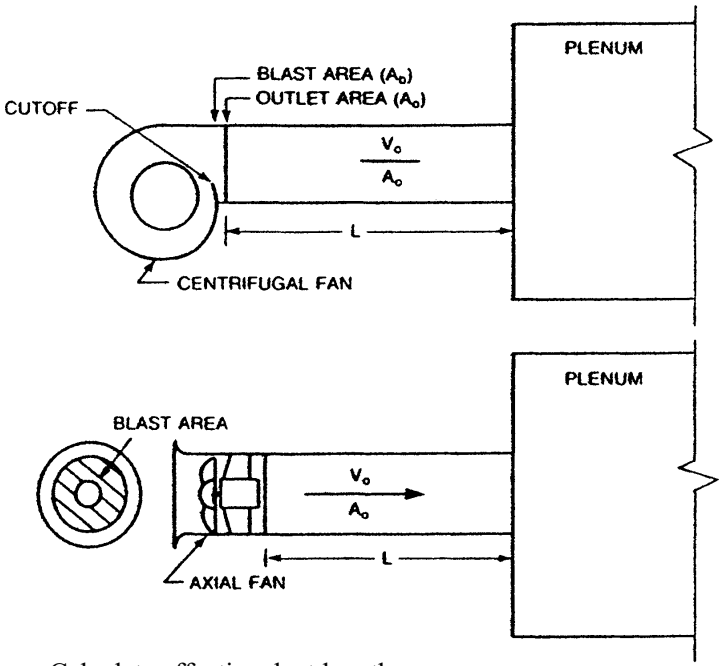
6-11 Rectangular Duct, Depressed to Avoid an Obstruction (SMACNA 1981, Table 6-14J)



C_o				
	L/H			
W/H	**0.125**	**0.15**	**0.25**	**030**
1.0	0.26	0.30	0.33	0.35
4.0	0.10	0.14	0.22	0.30

7 FAN-SYSTEM CONNECTIONS

7-1 Fans Discharging into a Plenum (AMCA 1973, Figure 19)



C_o					
	L/L_e				
A_b/A_o	**0**	**0.12**	**0.25**	**0.5**	**≥1.0**
0.4	2.0	1.0	0.40	0.18	0
0.5	2.0	1.0	0.40	0.18	0
0.6	1.0	0.66	0.33	0.14	0
0.7	0.8	0.40	0.14	0	0
0.8	0.47	0.22	0.10	0	0
0.9	0.22	0.14	0	0	0
1.0	0	0	0	0	0

Calculate effective duct length.

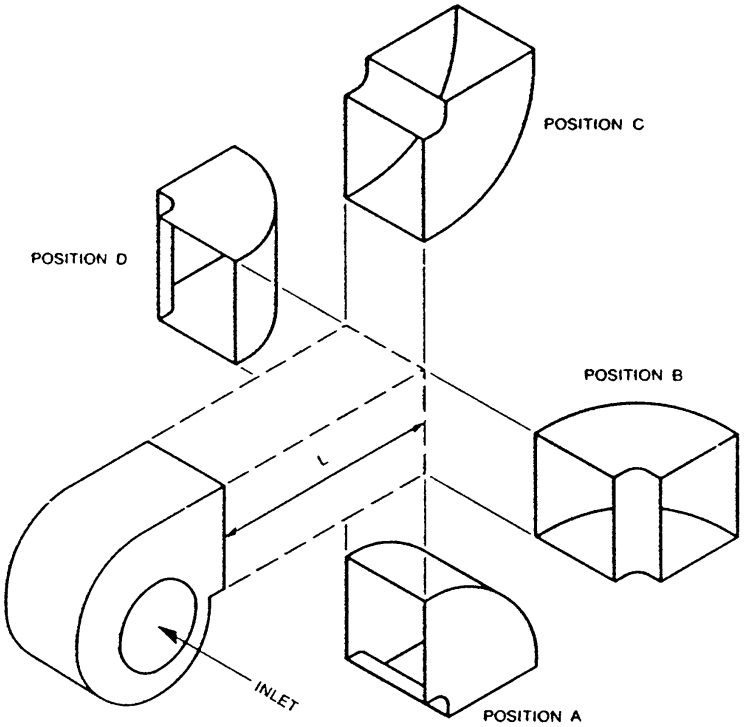
$V_o > 2500$ fpm: $L_e = V\sqrt{A_o}/10{,}600$

$V_o \le 2500$ fpm: $L_e = \sqrt{A_o}/4.3$

where

V_o = duct velocity, fpm
L_e = effective duct length, ft
A_o = duct area, in.^{2}

7-2 Single Width Single Inlet (SWSI) Fan with an Outlet Duct Elbow (AMCA 1973, Figure 22)



SWSI CENTRIFUGAL FAN

A_b = centrifugal fan blast area (see Fitting 7-1)

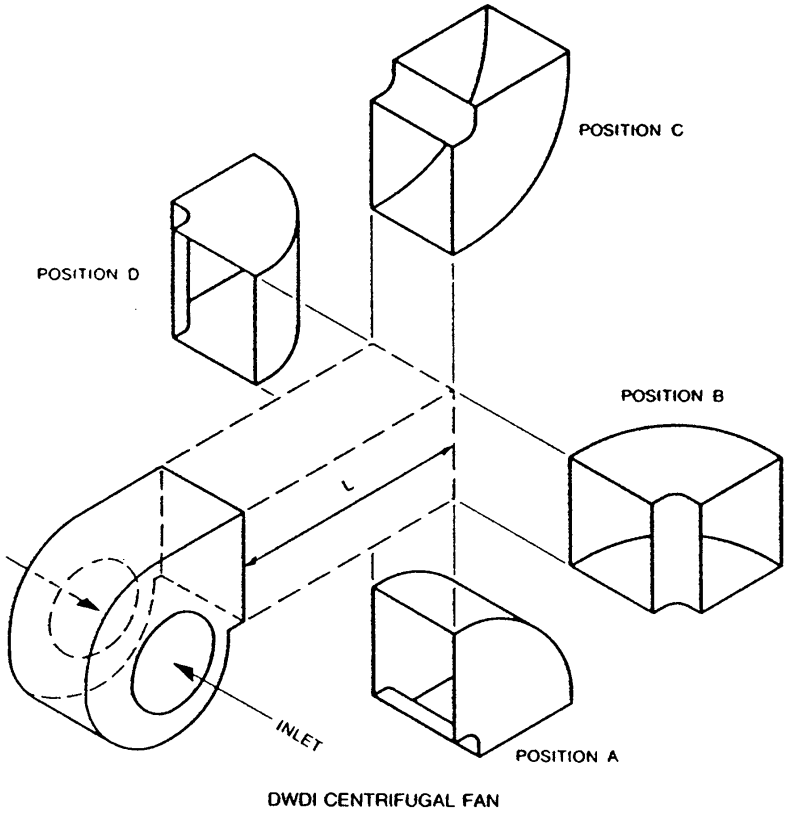
A_o = duct/outlet area (see Fitting 7-1)

To calculate effective duct length L_e, see Fitting 7-1.

		C_o				
		L/L_e				
A_b/A_o	Outlet Elbow Position	0	0.12	0.25	0.5	≥1.0
0.4	A	3.2	2.7	1.8	0.84	0
	B	4.0	3.3	2.2	1.0	0
	C	5.8	4.8	3.2	1.5	0
	D	5.8	4.8	3.2	1.5	0
0.5	A	2.3	1.9	1.3	0.60	0
	B	2.8	2.4	1.6	0.72	0
	C	4.0	3.3	2.2	1.0	0
	D	4.0	3.3	2.2	1.0	0
0.6	A	1.6	1.3	0.88	0.40	0
	B	2.0	1.7	1.1	0.52	0
	C	2.9	2.4	1.6	0.76	0
	D	2.9	2.4	1.6	0.76	0
0.7	A	1.1	0.88	0.60	0.28	0
	B	1.3	1.1	0.72	0.36	0
	C	2.0	1.6	1.1	0.52	0
	D	2.0	1.6	1.1	0.52	0

		C_o				
	Outlet Elbow Position	L/L_e				
A_b/A_o		0	0.12	0.25	0.5	≥1.0
0.8	A	0.76	0.64	0.44	0.20	0
	B	0.96	0.80	0.52	0.24	0
	C	1.4	1.2	0.76	0.36	0
	D	1.4	1.2	0.76	0.36	0
0.9	A	0.60	0.48	0.32	0.16	0
	B	0.76	0.64	0.44	0.20	0
	C	1.1	0.92	0.64	0.28	0
	D	1.1	0.92	0.64	0.28	0
1.0	A	0.56	0.48	0.32	0.16	0
	B	0.68	0.56	0.36	0.16	0
	C	1.0	0.84	0.56	0.26	0
	D	1.0	0.84	0.56	0.16	0

7-3 Double Width Double Inlet (DWDI) Fan with an Outlet Duct Elbow (AMCA 1973, Figure 22)



DWDI CENTRIFUGAL FAN

A_b = centrifugal fan blast area (see Fitting 7-1)

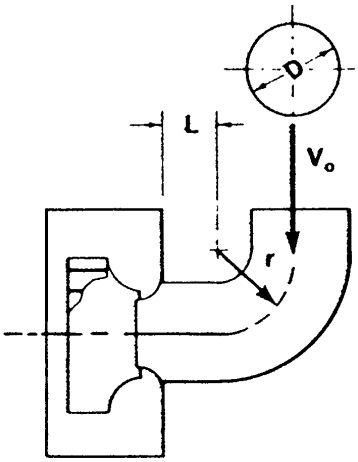
A_o = duct/outlet area (see Fitting 7-1)

To calculate effective duct length L_e, see Fitting 7-1.

C_o						
	Outlet Elbow Posi-	L/L_e				
A_b/A_o	tion	0	0.12	0.25	0.5	≥1.0
0.4	A	3.2	2.7	1.8	0.84	0
	B	5.0	4.2	2.8	1.3	0
	C	5.8	4.8	3.2	1.5	0
	D	4.9	4.1	2.7	1.3	0
0.5	A	2.3	1.9	1.3	0.60	0
	B	3.6	3.0	2.0	0.90	0
	C	4 0	3-3	2.2	1.0	0
	D	3.4	2.8	19	0.88	0
0.6	A	1.6	1.3	0.88	0.40	0
	B	2.5	2.1	1.4	0.65	0
	C	2.9	2.4	1.6	0.76	0
	D	2.5	2.1	1.4	0.65	0
0.7	A	1.1	0.88	0.60	0.28	0
	B	1.7	1.4	0.90	0.45	0
	C	2 0	1.6	1.1	0.52	0
	D	1.7	1.4	0.92	0.44	0

C_o						
	Outlet Elbow Posi-	L/L_e				
A_b/A_o	tion	0	0.12	0.25	0.5	≥1.0
0.8	A	0.76	0.64	0.44	0.20	0
	B	1.2	1.0	0.65	0.30	0
	C	1.4	1.2	0.76	0.36	0
	D	1.2	0.99	0.65	0.31	0
0.9	A	0.60	0.48	0.32	0.16	0
	B	0.95	0.80	0.55	0.25	0
	C	1.1	0.92	0.64	0.28	0
	D	0.95	0.78	0.54	0.24	0
1.0	A	0.56	0.48	0.32	0.16	0
	B	0.85	0.70	0.45	0.20	0
	C	1.0	0.84	0.56	0.28	0
	D	0.85	0.71	0.48	0.24	0

7-4 Nonuniform Elbow into a Fan Inlet Induced by a 90° Round Smooth Radius Elbow Without Vanes (AMCA 1973, Fig. 27)

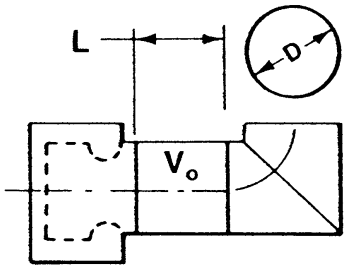


C_o			
	L/D		
r/D	0	2.0	≥5.0
0.75	1.4	0.80	0.40
1.0	1.2	0.66	0.33
1.5	1.1	0.60	0.33
2.0	1.0	0.53	0.33
3.0	0.66	0.40	0.22

7-5 Nonuniform Elbow into a Fan Inlet Induced by 90° Mitered and Multipiece Elbows Without Vanes (AMCA 1973, Fig. 29)

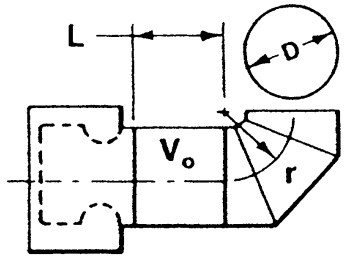
Mitered

L/D	0	2.0	≥5.0
C_o	3.2	2.0	1.0



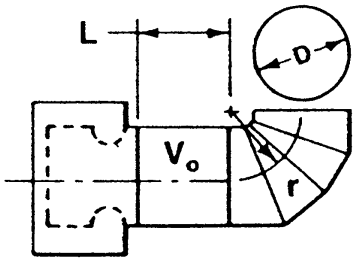
Three-Piece

	C_o		
	L/D		
r/D	**0**	**2.0**	**≥5.0**
0.50	2.5	1.6	0.80
0.75	1.6	1.0	0.47
1.0	1.2	0.66	0.33
1.5	1.1	0.60	0.33
2.0	1.0	0.53	0.33
3.0	0.80	0.47	0.26



Four-Piece or more

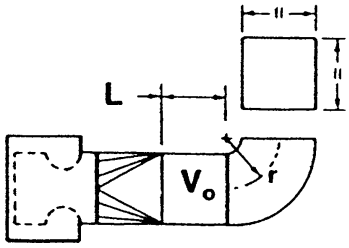
	C_o		
	L/D		
r/D	**0**	**2.0**	**≥5.0**
0.50	1.8	1.0	0.53
0.75	1.4	0.80	0.40
1.0	1.2	0.66	0.33
1.5	1.1	0.60	0.33
2.0	1.0	0.53	0.33
3.0	0.66	0.40	0.22



7-6 Nonuniform Elbow into a Fan Inlet Induced by a 90° Square Smooth Radius Elbow (AMCA 1973, Figure 35A)

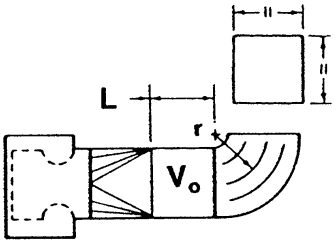
Square Elbow with an Inlet Transition,[a] No Vanes

	C_o		
	L/D		
r/D	**0**	**2.5**	**≥6.0**
0.50	2.5	1.6	0.80
0.75	2.0	1.2	0.66
1.0	1.2	0.66	0.33
1.5	1.0	0.57	0.30
2.0	0.8	0.47	0.26



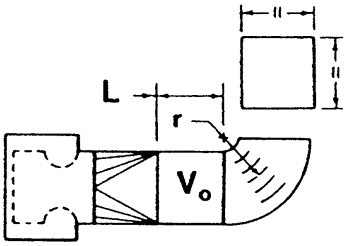
Square Elbow with an Inlet Transition,[a] Full Radius Vanes Equally Spaced

	C_o		
	L/*D*		
r/*D*	0	2.5	≥6.0
0.50	0.80	0.47	0.26
1.0	0.53	0.33	0.18
1.5	0.40	0.28	0.16
2.0	1.26	0.22	0.14



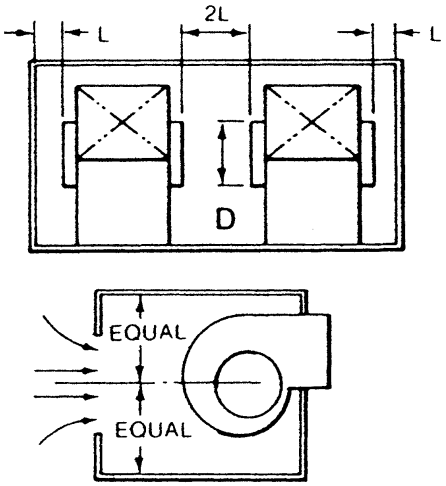
Square Elbow with an Inlet Transition,[a] Short Vanes per Fitting 3.8

	C_o		
	L/*D*		
r/*D*	0	2.5	≥6.0
0.50	0.80	0.47	0.26
1.0	0.53	0.33	0.18
1.5	0.40	0.28	0.16
2.0	0.26	0.22	0.14



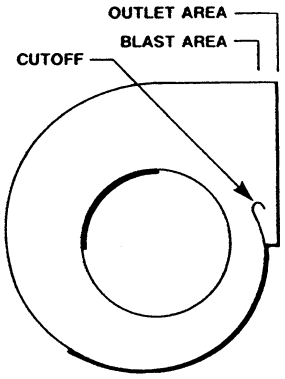
[a] The inside area of the square duct ($H \times H$) is equal to the inside area circumscribed by the fan inlet collar. The maximum angle of any converging element of the transition is 15° and, for a diverging element, 7.5°.

7-7 Fans Located in Plenums and Cabinet Enclosures (AMCA 1973, Figure 35A)



L	C_o
0.75 D	0.22
0.5 D	0.40
0.4 D	0.53
0.3 D	0.80
0.2 D	1.2

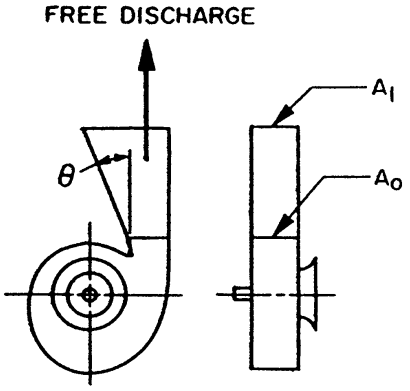
7-8 Fan Without an Outlet Diffuser (AMCA 1973, Figure 19)



Poor; should not be used.

A_b/A_o	0.4	0.5	0.6	0.7	0.8	0.9	1.0
C_o	2.0	2.0	1.0	0.80	0.47	0.22	0

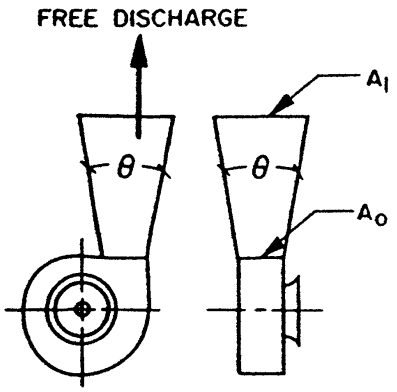
7-9 Plane Asymmetric Diffuser at Fan Outlet Without Ductwork (Idelchik et al. 1986, Diagram 11-11)



	C_o					
θ,	A_1/A_o					
degrees	1.5	2.0	2.5	3.0	3.5	4.0
10	0.51	0.34	0.25	0.21	0.18	0.17
15	0.54	0.36	0.27	0.24	0.22	0.20
20	0.55	0.38	0.31	0.27	0.25	0.24
25	0.59	0.43	0.37	0.35	0.33	0.33
30	0.63	0.50	0.46	0.44	0.43	0.42
35	0.65	0.56	0.53	0.52	0.51	0.50

If diffuser has a screen, use Fitting 6-7 to calculate screen resistance.

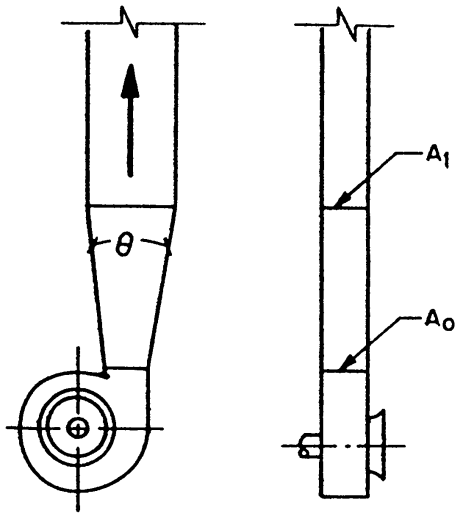
7-10 Pyramidal Diffuser at Fan Outlet Without Ductwork (Idelchik et al. 1986, Diagram 11-11)



	C_o					
θ,	A_1/A_o					
degrees	1.5	2.0	2.5	3.0	3.5	4.0
10	0.54	0.42	0.37	0.34	0.32	0.31
15	0.67	0.58	0.53	0.51	0.50	0.51
20	0.75	0.67	0.65	0.64	0.64	0.65
25	0.80	0.74	0.72	0.70	0.70	0.72
30	0.85	0.78	0.76	0.75	0.75	0.76

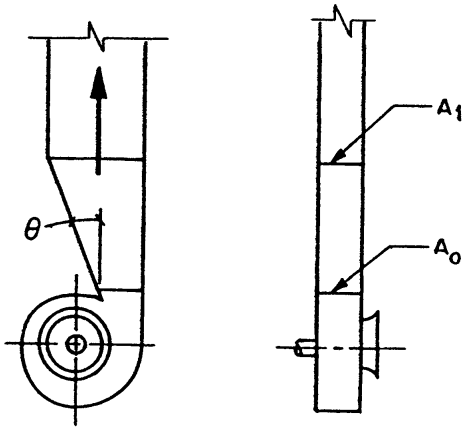
If diffuser has a screen, use Fitting 6-7 to calculate screen resistance.

7-11 Plane Symmetric Diffuser at Fan Outlet with Ductwork (Idelchik et al. 1986, Diagram 5-12)



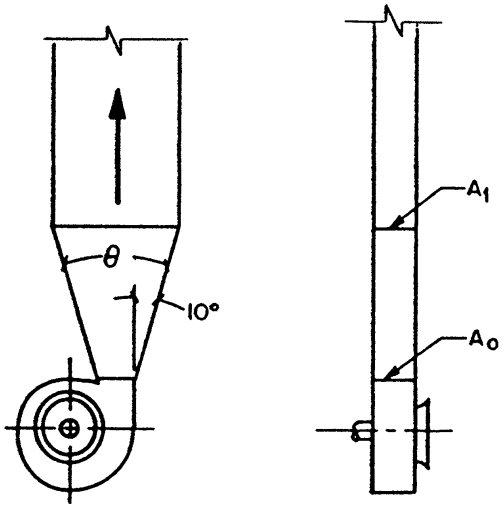
	C_o					
θ,	A_1/A_o					
degrees	1.5	2.0	2.5	3.0	3.5	4.0
10	0.05	0.07	0.09	0.10	0.11	0.11
15	0.06	0.09	0.11	0.13	0.13	0.14
20	0.07	0.10	0.13	0.15	0.16	0.16
25	0.08	0.13	0.16	0.19	0.21	0.23
30	0.16	0.29	0.39	0.32	0.34	0.35
35	0.24	0.34	0.39	0.44	0.48	0.50

7-12 Plane Asymmetric Diffuser at Fan Outlet with Ductwork (Idelchik et al. 1986, Diagram 5-13)



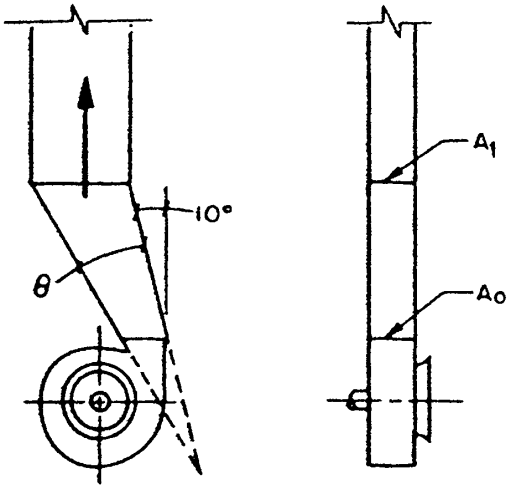
	C_o					
θ,	A_1/A_o					
degrees	1.5	2.8	2.5	3.0	3.5	4.0
10	0.08	0.09	0.10	0.10	0.11	0.11
15	0.10	0.11	0.12	0.13	0.14	0.15
20	0.12	0.14	0.15	0.16	0.17	0.18
25	0.15	0.18	0.21	0.23	0.25	0.26
30	0.18	0.25	0.30	0.33	0.35	0.35
35	0.21	0.31	0.38	0.41	0.43	0.44

7-13 Plane Asymmetric Diffuser at Fan Outlet with Ductwork (Idelchik et al. 1986, Diagram 5-14)



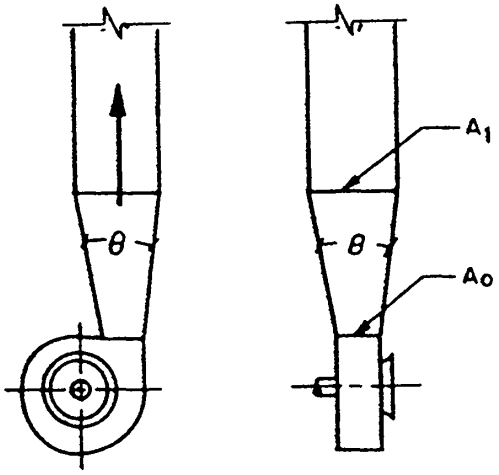
	C_o					
θ,	A_1/A_o					
degrees	1.5	2.8	2.5	3.0	3.5	4.0
10	0.05	0.08	0.11	0.13	0.13	0.14
15	0.06	0.10	0.12	0.14	0.15	0.15
20	0.07	0.11	0.14	0.15	0.16	0.16
25	0.09	0.14	0.18	0.20	0.21	0.22
30	0.13	0.18	0.23	0.26	0.28	0.29
35	0.15	0.23	0.28	0.33	0.35	0.36

7-14 Plane Asymmetric Diffuser at Fan Outlet with Ductwork (Idelchik et al. 1986, Diagram 5-15)



	C_o					
θ,	A_1/A_o					
degrees	1.5	2.8	2.5	3.0	3.5	4.0
10	0.11	0.13	0.14	0.14	0.14	0.14
15	0.13	0.15	0.16	0.17	0.18	0.18
20	0.19	0.22	0.24	0.26	0.28	0.30
25	0.29	0.32	0.35	0.37	0.39	0.40
30	0.36	0.42	0.46	0.49	0.51	0.51
35	0.44	0.54	0.61	0.64	0.66	0.66

7-15 Pyramidal Diffuser at Fan Outlet with Ductwork (Idelchik et al. 1986, Diagram 5-16)



	C_o					
θ,	A_1/A_o					
degrees	1.5	2.8	2.5	3.0	3.5	4.0
10	0.10	0.18	0.21	0.23	0.24	0.25
15	0.23	0.33	0.38	0.40	0.42	0.44
20	0.31	0.43	0.48	0.53	0.56	0.58
25	0.36	0.49	0.55	0.58	0.62	0.64
30	0.42	0.53	0.59	0.64	0.67	0.69

8 References

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